DEATH IS BUT THE NEXT GREAT ADVENTURE: PLANNING AND MANAGING CEMETERIES IN THE LANGEBERG MUNICIPALITY IN THE WESTERN CAPE

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ABSTRACT

Cemeteries have always been part of the human environment. In recent years the availability for new cemeteries have become difficult to obtain, as the population have grown and the increasing demand for other land use development like housing and commercial infrastructure have caused the development of new cemeteries to be a less dominant priority. Municipalities are facing a huge problem in providing suitable land to develop new cemeteries and managing the existing cemeteries. The Langeberg Municipality is one of such an example where the municipality is struggling to provide suitable areas for new cemeteries in the towns of the Langeberg District. This study used the CSIR cemetery formula to calculate the required areas needed to develop new cemeteries of each of the towns, as well as providing the area needed to develop regional cemeteries in the Langberg District. The literature in this study provided the specific factors, which is used in a Multi Criteria Evaluation (MCE) that weigh these factors according to a set criteria, which determine the optimal location for new local and regional cemeteries. This study managed to propose 18 new cemeteries and 3 new regional cemeteries, which could be developed in and around the towns of the Langeberg District. These cemeteries met all the criteria which was used in the MCE tool. Clear planning and management strategies is also discussed in this study, providing the Langeberg Municipality with clear solutions to overcome the cemetery crisis that they are recently in After the result where mentioned in this study, important implications and recommendations regarding the development of new local and regional cemeteries in the Langeberg District are discussed.

Keywords and phrases: Langeberg District municipality; multi-purpose cemeteries; CSIR cemetery formula; Multi Criteria Evaluation (MCE) tool; planning and management strategies

OPSOMMING

Begraafplase was nog altyd deel van die menslike beskawing. Alhoewel in die afgelope jaar het ontwikkeling van nuwe begraafplase ‘n moeilike proses geraak het, as gevolg van die drastiese bevolkingsgroei en die toenemende vraag na ander grondgebruiksontwikkeling soos behuising en komersiele infrastruktuut, het veroorsaak dat die ontwikkeling van nuwe begraafplase ‘n minder dominante prioriteit geword het. Munisipaliteite ondervind dus 'n groot probleem in die voorsiening van geskikte grond om nuwe begraafplase te ontwikkel en die bestaande begraafplase te bestuur. Die Langeberg Munisipaliteit is een van so 'n voorbeeld waar die munisipaliteit sukkel om geskikte gebiede te voorsien vir nuwe begraafplase in die dorpe van die Langeberg Distrik. Hierdie studie het die WNNR-begraafplaasformule gebruik om die vereiste areas te bereken wat nodig is om nuwe begraafplase van elk van die dorpe te ontwikkel, asook om die gebied te voorsien wat nodig is om streeksbegraafplase in die Langberg-distrik te ontwikkel. Hierdie studie het daarin geslaag om 18 nuwe begraafplase en 3 nuwe streeksbegraafplase voor te stel, wat in en om die dorpe van die Langeberg-distrik ontwikkel kan word. Hierdie begraafplase voldoen aan al die kriteria wat in die MKE-instrument gebruik is. Duidelike beplannings- en bestuurstrategieë word ook in hierdie studie bespreek, en bied aan die Langeberg Munisipaliteit duidelike oplossings om die begraafplaaskrisis wat hulle onlangs ervaar, te oorkom. Na die resultate bespreek was in die studie, word belangrike implikasies en aanbevelings aangaande die ontwikkeling van nuwe plaaslike- en streeks begraafplase in die Langeberg-distrik bespreek.

Trefwoorde en frases: Langeberg Distrik Munisipaliteit; Veelsydige begrafplase; WNNR-begraafplaas formule; Multi-kriteria evaluering (MKE) instrument; beplanning en bestuurs strategieë

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ABBREVIATIONS AND ACRONYMS

		Page
LDM	Langeberg District Municipality	2
CSIR	Council for Scientific and Industrial Research	3
MCE	Multiple Criteria Evaluation	3
CBD	Central Business District	6
SPLUMA	Spatial Land Use Management Act	7
DWAF	Department of Water Affairs and Forestry	9
GFPS	Grave-Free Promotion Society	10
SALGA	South African Local Government Association	10
SDA	Secondary data analysis	14
SANBI	South African National Biodiversity Institute	17
CGA	Centre for Geographical Analysis	17
GIS	Geographic Information System	17
IDP	Integrated Development Plan	73
SDF	Spatial Development Framework	73

CHAPTER 1: SETTING THE SCENE

"After all, to the well-organised mind, death is but the next great adventure" - J.K.Rowling

1.1 INTROUDUCTION

Cemeteries or burial grounds were always part of the human environment. The certain truth of humanity's mortality, forces human societies to learn how to cope with death and its involvement in life. Cemeteries indicate a place of remembering and acknowledging the life of loved ones. Cemeteries are observed as the deceased connection place, between this world and the next one (Miller & Rivera 2006). The increased population growth, leading to an increased mortality rate, caused the lack of availability of space for new burials in cemeteries (Coutts et al., 2011). New land for cemeteries within populated metropolitan areas becomes increasingly difficult to obtain, as it became the less dominant priority to be designed, as an increasing demand for other infrastructure in these areas exist, such as housing (Hariyono 2015; Capels & Senville 2006). Planners need to realise that houses could be build adjacent and offices could be shared. All buildings could be stacked on top of each other, but this cannot be achieved with cemeteries. The mortality rate can be decreased, but what was buried, cannot be replaced. The only option for cemeteries is to extend. Cemeteries also require administration and financial resources to be protected and maintained (Capels & Senville 2006). It is important to introduce sustainable management strategies, ensuring cemetery development and management is maintained. Management strategies' main goal should be to counteract these challenges in dense populated areas globally.

1.2 RESEARCH PROBLEM

The municipalities in South Africa face a challenge regarding cemetery management and providing suitable land to develop new cemeteries. The literature, used in this study, indicate several challenges, for municipalities regarding developing new cemeteries. A shortage of land for cemeteries across South Africa are indicated, resulting the rapid population growth of 1.6% annually (Stats South Africa, 2016). The popular demand for land-use developing, signifies that housing, government and local authorities focus on providing houses for the local citizens. This is causing cemetery land to decrease, obstructing providing land for new cemeteries.

In South Africa, cemeteries were developed on the outskirts of the towns. The rapid population growth and an increase in urbanisation, in search of job opportunities, caused the challenge of cemeteries being situated on unsuitable land. Contributing to this challenge could be the lack of knowledge by government in the past, that should have been more sensible, not to develop a cemetery on an unsuitable land (SLGA 2015).

Municipalities indicate an insufficient budget for new cemetery management. The challenge can only be solved by proper management and as indicated, a lack of cemetery management exists. This lack can evolve a circle requiring government to take action before it is too late and no optimal location is left to develop new cemeteries in South Africa, specifically in the Western Cape, in the Langeberg district.

1.3 RESEARCH QUESTIONS

The research indicates the following questions:

a) What are the main findings in the literature pertaining the size and locations of cemeteries globally and what are the planning and management demands for cemeteries?
b) Where are the cemeteries located in the main towns of the Langeberg District Municipality (LDM), in the Western Cape (Montagu, Robertson, Ashton, McGregor and Bonnievale) and how much capacities are used in these cemeteries?
c) What is the total area needed for developing new regional cemeteries in the LDM?
d) What are the main factors determining the optimal location of cemeteries, based on data availability?
e) Where and how do these factors influence the optimal locations for developing new regional cemeteries in the LDM?
f) Where should the new regional cemeteries be situated in the LDM.
g) What new planning and management strategies can be implemented, ensuring the sustainable use of existing and new cemeteries in the LDM area?

1.4 AIM AND OBJECTIVES

This study indicates two main aims: 1) to determine the optimal size and location for developing new local and regional cemeteries in the LDM; and 2) to provide sustainable planning and management strategies for the current and new cemeteries in the LDM area.

The aims of this study are achieved through the following objectives:

a) Review the existing literature for the various techniques available to determine the optimal size and location of various land-uses, but more specifically the size and location of cemeteries, the factors influencing the optimal size and locations for developing cemeteries and the sustainable planning and management solutions for existing and new cemeteries globally.
b) Map existing locations of the local cemeteries in the LDM.
c) Determine the optimal size through the total area, needed for developing new regional cemeteries in the LDM, using the Council for Scientific and Industrial Research's (CSIR) formulas as a cemetery size calculation technique.
d) Determine and map all of the factors using ArcMap that influence the optimal locations for developing new regional cemeteries in the LDM.
e) Determine the optimal locations for developing new regional cemeteries in the LDM by weighing all the identified factors against each other, using the Multiple Criteria Evaluation (MCE) tool.
f) Provide sustainable planning and management strategies for the existing and new cemeteries, for the LDM.

1.5 REPORT STRUCTURE

Chapter 1 discuss the research process followed, the real world problem, the research problem, the research questions, aim and objectives and methodology. Chapter 2 discusses an in depth study of the literature review. Chapter 3 explains the methodology, comprising the epistemology and meta-theory associated with the topic, study area, data sources, data collection, data sampling, data design, data processing and analysis. Chapter 4 emphasis the results and discussions, providing management and planning strategies. Chapter 5 provides a synthesis of the main findings, along with recommendations, limitations and future research.

CHAPTER 2: THE DEVELOPMENT AND MANAGEMENT OF EXISTING AND NEW CEMETERIES: EXAMPLES FROM THE LITERATURE

The availability of cemetery land becomes a major concern for urban planners, struggling to find sufficient land to be permanently allocated for cemeteries. Whilst the demand for additional land-uses rise (housing and commercial land-uses), the available space for cemetery development is decreasing. Although the housing land-use is one of the most demanding land-use as indicated in the literature, it is considered that the cemeteries represent an important land-use for neighbourhoods; it is included in the infrastructure of human settlements globally (Niţă et al. 2013). The literature for this study focusses on the theories of the concept of land-use management. Cemeteries are associated with a form of land-use. After the theory concepts are explained, the remainder of the literature focuses on the factors influencing developing cemeteries, including management strategies for existing and new cemeteries.

2.1 THEORIES EXPLAINING THE CONCEPT LAND USE MANAGEMENT FOCUSING ON THE DEVELOPMENT OF CEMETERIES.

Land-use is the term classifying the activity on the land, or the purpose for which the land is used. In the early 19th century, Johann Heinrich von Thünen developed a model of land-uses (Nelson 2002). This model explains how market processes could determine land-use in various locations. The assumptions of this theory indicate:

- The city or market is located in in the centre of the “isolated state”, self-sufficient with no external influences;
- An unoccupied wilderness and land surround the isolated state is completely flat with no interruptions like rivers or mountains;
- The soil quality and climate are consistent throughout the state, with farmers transporting their own goods across land, directly to the central city, indicating a lack of roads (O’Kelly & Bryan 1996).

Figure 2.1 illustrates the four concentric rings around the city, which Von Thünen used, explaining what type of farming activity should be situated where and why, indicating the land and transportation cost. Dairy and intensive farming are situated near the market or city, as fruit, milk and other dairy products must be transported to the market rapidly, as these products become rotten or sour quickly (Miguel 2013). The second concentric ring, situated around the city or market, indicates foresting, used for timber and firewood, for fuel and building materials. It is heavy and difficult to transport therefore this agriculture activity needs to be close to the city centre (Miguel 2013). Field crops are situated further, as grains last longer than dairy products and are light, indicating less transport costs (Miguel 2013). The farming activity situated the furthest from the city centre, indicates cattle ranching. According to Von Thünen's land-use model, the cattle could walk to the towns and it takes much longer for cattle to be full grown before they can get slaughter (Nelson 2002; (Miguel 2013; O'Kelly & Bryan 1996).

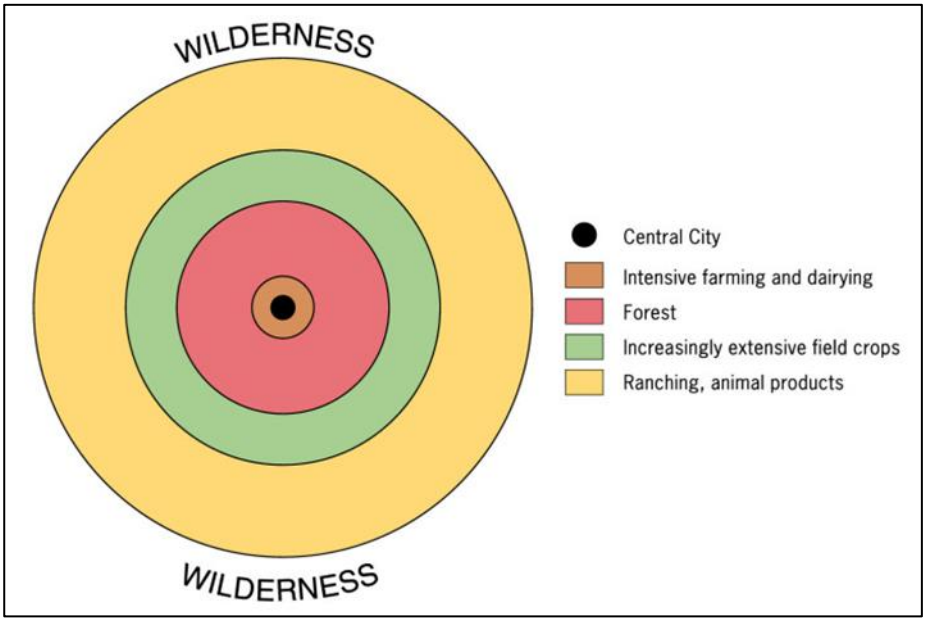

Figure 2.1 Von Thunen's Model (Source: Miguel 2013)

This conclusion to Von Thünen's model inspired developing the bid rent curve theory, also known as the modern urban land-use theory. William Alonso succeeded in generalising the Von Thünen's theory, modifying it for urban use, considering aspects, such as population density, employment and urban context, creating the modern urban land-use theory. (Fujita 1989; O'Kelly & Deborah 1996). In the land-use theory land closer to the city or market was more expensive, though transportations costs were lower. Land further away from the city or market was cheaper, with higher transportation costs. Instead of just focussing on the agricultural land-use as completed by Von Thünen, the bid rent theory focusses on the price and demand for various real estate changes, as the distance from the

central business district increases, creating various land-uses in a city. Figure 2.2 indicates the type of land-use prepared to and able to pay for good access to the CBD:

- Commerce (chain stores) are located close to the CBD, willing to pay a high rent to be located in and close to the CBD;
- The industry is willing to pay to be on the outskirts of the CBD, as there is more land available for their factories. It is still beneficial, situated near the CBD;
- As the land becomes cheaper, distant from the CBD, the householders can purchase the land. The bid rent theory clearly indicates the residential land-use type, distant from the CBD.

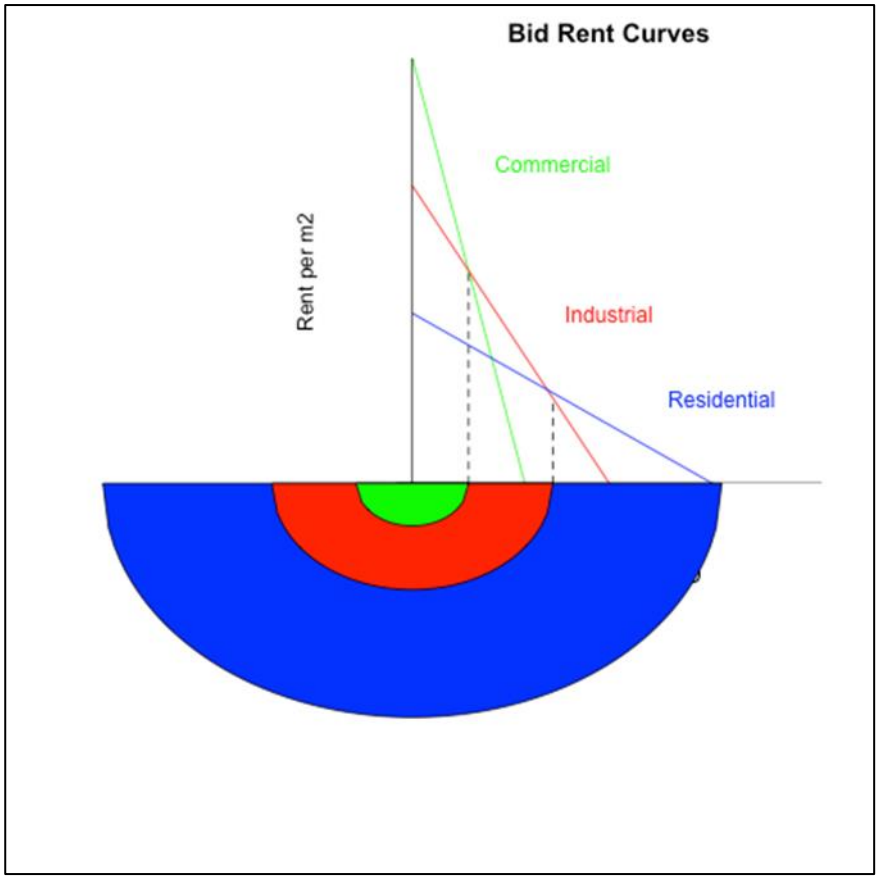

Figure 2.2 Bid rent curve (Source: stackoverflow 2017)

Although these two theories are not the main contributors to land-use types in cities and rural areas, they indicate the foundation, explaining the various land-use types. As seen in Figure 2.2, the modern urban land-use theory (bid rent theory) explains the various land-uses, found in a city. The bid rent theory is not directly linked to explaining the existence or developing cemeteries. The theory clarifies industrial areas, commercial areas and residential areas developed over time. Whilst focussing on an economic background, this theory also explains why these various areas are situated in the city. As previously mentioned in the literature, cemeteries represent an important land-use for neighbourhoods

and with the bid rent explaining where these neighbourhoods are situated, the location and developing cemeteries could be linked with this theory, as cemeteries are situated near neighbourhoods. (O'Kelly & Deborah 1996).

Factors influencing the various land-uses in a city include zoning regulations, environmental and social-economic influences. These factors may eventually impact the location of cemeteries (Iwata & Oguchi 2009). Zoning regulations are deemed to be a municipal responsibility, shaping a city or a town in most countries, such as South Africa, the United States and Germany. In Japan, these regulations are determined at a national level (Fischel 1999; Hirt 2010; Shibata 2002; SPLUMA 2013). Comparing the American and German approach to various land-uses, institutes that in the United States, the zoning approach is regularly based on the assumption of exclusivity (each land-use is suitable for a specific single type of human activity). In Germany the principle indicates predominance; land-use is suitable for multiple types of human activity and most district is essentially mixed use. Japan's zoning regulations also largely encourages mixed land-use, due to minimum land to develop, such as in huge cities (Hirt 2010; Iwata & Oguchi 2009). South Africa is still in the same circumstances as America. An innovative method incorporating the mixed land-use approach, like in Germany and Japan, is of utmost importance to protect urban sprawl and the decrease of lost in green space on the edges of the towns. The Spatial and Planning Land-Use Management Act emphasises this challenge, though a need for improvement is still indicated (Ntiwane 2012; SPLUMA 2013).

Environmental issues also impact the land-use type in a city. As farmland usually requires open, huge space, industrial areas also need to be developed on level ground. Factories cannot be developed on a steep slope. Residential areas also need open space with clean air and green spaces. This is why neighbourhoods are situated on the outer skirts of cities (Pauleit et al. 2005; Wu 2017). As urban areas are usually linked with several environmental challenges, including air pollution and water pollution, this seems to be the perfect place for commercial activity as all the chain stores and head offices are adjacent in the CBD, as seen in the UK (Pauleit et al. 2005).

Social-economic influences could also impact developing various land-use types. When referring to social-economic influences, the following factors can explain the concept: persons goal, occupation or life change can have an impact on where they want to live, which could have a broad impact on the land-use type of an area as more individuals relocate to a certain place, satisfying the social-economic need, leading to a higher demand for neighbourhoods in certain cities (William & Schirmer 2012). Labour and capital is also a main factor, drawing individuals to certain cities, influenced by

these socio-economic factors, indicated in the region of South-East Australia (William & Schimmer 2012; Wu 2017).

Al these factors influencing the land-use types in various cities globally, influence locations of certain cemetery development. As mentioned, the zoning regulations, environmental and socio-economic issues, influence developing neighbourhoods, effecting developing cemeteries. Cemeteries are usually developed close to residential land-use areas. The following section focusses on factors contributing in developing cemeteries, shifting from explaining developing various land-use types in cities. The focus is on the theories mentioned above, mentioning the factors influencing the various land-use locations.

2.2 FACTORS INFLUENCING THE DEVELOPMENT OF CEMETERIES.

Several factors can contribute to cemeteries location and their specific size. Cemeteries are the only land-use type, planned for permanent use. The town planner has to carefully plan and consider several factors, prior determining the best suitable location for the developing cemeteries. This section in the literature clarifies important factors considered, whilst planning new cemeteries. This section discusses, determining the specific size of the cemetery. The following part of this section discusses restriction guidelines from environmental organisations, considered when determining new cemeteries.

It is important to plan for a required size of land for cemeteries, by considering factors, such as population size of the town, total deaths accursing in a town and specific documents and guidelines, providing additional information on required plot sizes. Various articles indicate several calculation types, assisting in determining the size of a specific cemetery. As the space for developing cemeteries decrease in cities globally, a formula is needed, that could assist determining the best optimal size for a new cemetery development. A study was conducted, indicating a specific equation used in attempting to determine the optimal cemetery size, needed to meet the demand for a specific projection period (Coutts et al. 2011). This current study focusses on the LDM. It is important to use appropriate documents and cemetery size formulas, to determine the optimal size of planned cemeteries. After the specific size is calculated, the next step indicates, the search for an optimal location to develop a new cemetery.

Global municipalities and govern bodies use planning guidelines to determine various land-use development. Although cemeteries are not the most popular land-use development type, several

countries still have guidelines and restrictions, assisting the process, determining the location of new cemeteries. In the UK, the Northern Ireland Environment Agency developed a guideline that the planners in the surrounding are obliged to use when determining new cemeteries. This guideline provides planning assistance to the town planners. It assists the planners to reach a consistent approach planning for cemeteries (NIEA 2016).

South Africa holds a water quality management policy, managing and controlling cemeteries as a cause of water pollution. The Department of Water Affairs and Forestry (DWAF), developed this policy. The local authorities should take cognisance of the requirements of this policy in their planning scheme, as it relates to the location and developing of new cemeteries. These requirements indicate that cemeteries should:

- Not be located below the one in 50-year flood line of a river;
- Not be close to water systems, such as wetlands, floodplains and estuaries;
- Not be situated on unstable areas, such as fault zones, dolomitic of karst areas where sinkholes and subsidence are likely to occur;
- Not be situated in or near sensitive ecological areas;
- Not be situated in or on areas characterised by flat gradients, or shallow groundwater;
- Not be situated in areas, characterised by steep gradients, or shallow bedrock with little soil cover, where the stability of the slopes could indicate a challenge;
- Not be situated on areas overlaying or adjacent to important aquifers, supplying water (DWAF, 2015).

All these physical factors must be considered when developing new cemeteries. This paragraph advises on how the traditions of a community can influence the location and development of a new cemetery. Several cultures and religions hold various burial ceremonies and specific requirements, indicated by certain traditions. These could influence the location of the cemetery, as the individuals might insist these requirements otherwise they will not use the cemetery and the land will be wasted space. Several burial ceremonies globally, influence determining the location of the cemetery. For several African countries burying the death is a sacred ritual, important for these individuals, requiring adequate space to lay their loved ones to rest.

In South Africa, the Xhosa tradition (for example) believe that life does not end with death but enters the new real. Their tradition indicates that when a person dies, they must be provided a proper tradition and ceremony. It is also tradition for the family to return the dead to their homeland for

burial. This could impact these homelands, as the space for a proper burial is decreasing (Ngcongo 2005; Comparethecoffins 2017).

In Great Britain and Japan, the traditional bury traditions decreased as more individuals perceptive change in favour for cremation. In South Korea cremation became popular after the year 2000, as a law was enforced, indicating that everyone who bury a loved one, must remove their grave in 60 years because of the lack of space (May 2013; Prothero 2004). Although the popularity of cremation drastically increased over the years in Europe and the Eastern countries, America's cremation figure surprisingly stayed low. American citizens in general, remain religious and believe that the body needs to be buried (Prothero 2004). As seen above, traditions could have a huge impact on the location of a new cemetery. Tradition needs to be considered when deciding on the optimal location of a cemetery.

2.3 SUSTAINABLE MANAGEMENT STRATEGIES FOR EXISTING AND NEW CEMETERIES

The management of new and existing cemeteries became more important in developing cemeteries in urban areas. Certain articles indicate that new ways focus on reducing the land space of cemeteries. The concept of vertical cemeteries is one of the proposed solutions (Hariyono 2015). Countries like Brazil, Israel and Bolivia already constructed such cemeteries, because of a lack of open space in urban areas. In Japan, the Grave-Free Promotion Society (GFPS) was formed in the 1990's. This group was established to promote the scattering of human ashes in Japan. This 'grave revolution' commenced at the end of the 1980s, because of the lack of space (Rowe 2003). American citizens mostly represent Christianity; therefore, the cremation scope is still low. The number of individuals in America, opting for environmentally friendly burial is increasing. Green funerals, also known as natural burial is a way of caring for the dead with minimal environmental impact, in so reducing the carbon emission and ensuring the restoration and/or preservation of the surrounding habitat (GBC 2017). The United States indicated several (40 plus) environmentally friendly cemeteries (Basmajain & Coutts 2010; Shamme 2010). Another method reducing cemetery space is grave sharing, where burial plots would be open up and dug deeper, to provide stacking space for more people (Johnstone 2004). This is already prominent in countries such as Australia and the United Kingdom, where the remains of a body are buried deeper to create space for new burial places (Basmajain & Coutts 2010; Johnstone 2004).

In South Africa, the South African Local Government Association (SALGA) strategy plan assist to identify, source and document good practices on cemetery management from municipalities and partner organisations (SALGA 2016). This document help to develop focus on the cemetery management challenges for municipalities (SALGA 2016).The focus on environmental sustainability should be a main priority in cemetery management.

Figure 2.3 illustrates how cemeteries could be developed, supporting sustainability (SALGA 2015).

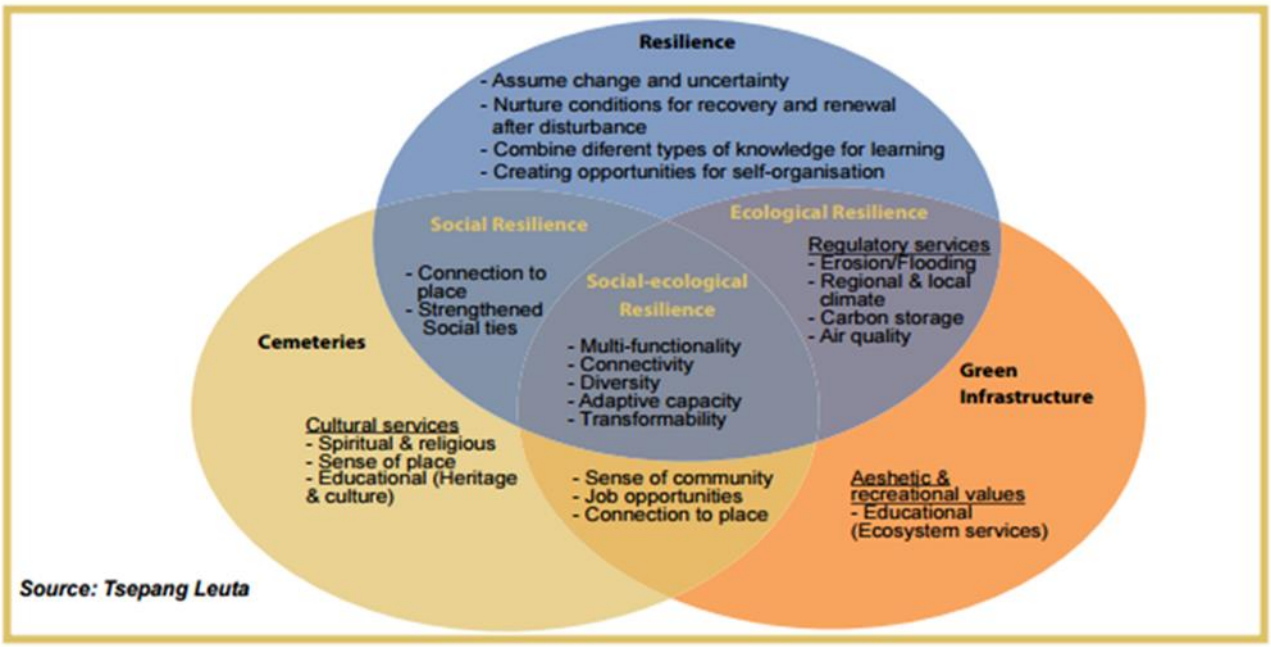

Figure 2.3: Developing cemeteries on a sustainable manner (Source: SALGA 2015)

2.4 CONCLUSION

Cemetery space availability becomes a huge challenge in highly populated countries. New methods and sustainable management guidelines is needed, ensuring proper development and management of new cemeteries. The literature review clarifies the theories, explaining land-use management. Cemeteries indicate the most unique land-use, as it needs to be developed for permanent use. Factors influencing the location of cemeteries, indicates the size of a new cemetery, guidelines developed in assisting the cemetery planning process and the traditions of the individuals living in a specific area. It is of utmost importance that urban planners focus on these factors, prior to deciding on the location of new cemeteries. The last section explains the importance of sustainable cemetery management strategies, to protect the environment, ensuring existing and new cemeteries are being used in a sustainable manner.

CHAPTER 3: METHODOLOGY

The methodology describes the technique in which the study is conducted. This study was divided into five key processes, as indicated in the research design (Figure 3.1). After revising the relevant literature relating to the study topic, the first process included a research challenge and two aims formulated, establishing specific objectives. In the second process, a comprehensive study was conducted, focussing on global literature, determining the methods used to calculate the size for new cemeteries and the factors influencing the development of new regional cemeteries. This process included management strategies of new and existing cemeteries.

The third process comprised data collection. A mixed method approach, including both qualitative and quantitative was used to collect spatial and statistical data, calculating the cemetery sizes and compile maps. The cemeteries were calculated by using the CSIR cemetery formula, comprising the population data of each town, the total deaths and the gross area of graves for the population. The factors influencing the location of new regional cemeteries, was determined after reviewing the literature, suggesting land cover, rivers, wet lands, protected areas and slopes. Various data sets provided the CSIR cemetery calculations and specific factors for the LDM, explained in the Section 3.4.

Process 4 comprised the data processing and analysis, assisting in achieving objectives established in the first process. The CSIR cemetery formula used in the study, calculated the area volume needed for developing new cemeteries in every town, including the location to develop a regional cemetery. The CSIR guidelines further indicated the size of the new cemeteries. This process of the formula and analysis, determining the size of these new cemeteries, are explained in Section 3.5, indicating the data process and analysis. The factors influencing the new cemeteries location, were compared, using an MCE device in GIS. The suitable locations for new cemeteries were presented on ArcMap. Section 3.5 also discusses the process of the MCE device used in this study and the steps followed, identifying a location for new regional cemeteries in the LDM.

Chapter 5 comprises the final process, indicating sustainable planning and management strategies, followed by a summary and synopsis of the significant findings of this project. Chapter 5 also indicates recommendations for future research.

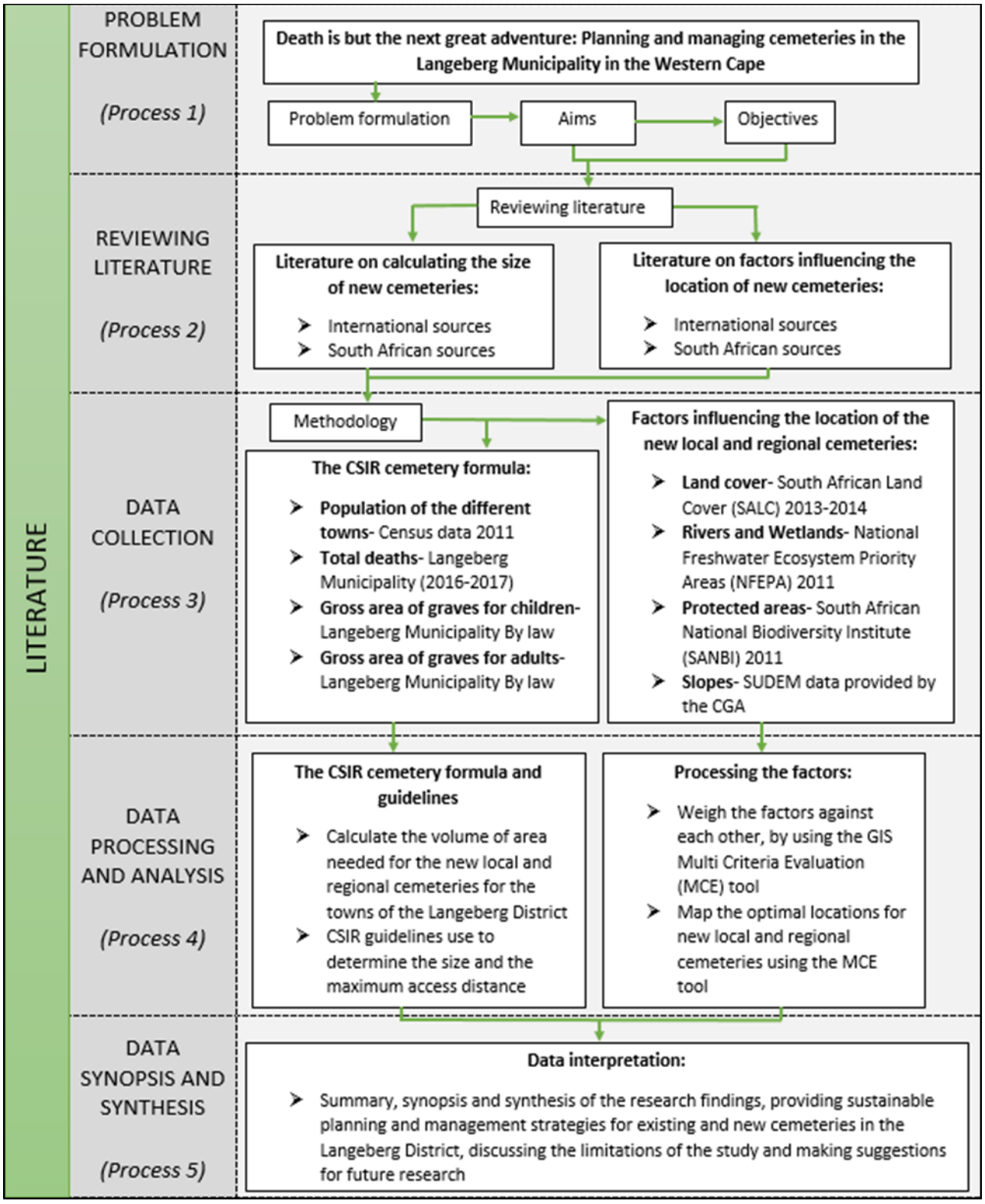

Figure 3.1: Research design (Source: Author 2017)

3.1 EPISTEMOLOGY AND META-THEORY ASSOCIATED WITH DETERMINING THE OPTIMAL LOCATION AND PROVIDING MANAGEMENT STRATEGIES FOR NEW CEMETERIES

This study indicated an empirical study, based on a positivistic meta-theory. Empirical studies are known as a study, developing a research challenge through the collected data (Barnard 2001). This research project will use a secondary data analysis (SDA) (Mouton, 2001). This research project aim, was to determine the size of the new cemeteries and their location. Secondary data was therefore collected from the LDM. The South African Land cover data set and the census data were consulted to determine the population of the towns in the LDM. This study also adopted an inductive idiographic approach, where the lack of cemetery space was identified as a real-world problem. The data provided by the LDM, provided a unique explanation. A solution could be determined by the results.

3.2 STUDY AREA

The focus area of this study was the Langeber District Municipality (LDM), situated in the Western Cape (Figure 3.1). The total area included in the LDM, is 4 518 km^2, comprising five main towns, indicating, Ashton, Bonnievale, McGregor, Montagu and Robertson. Robertson is the largest town in the LDM with a population of 27 715, whilst McGregor is the smallest town with a population of 3 125 (Census, 2011). This study focussed on these towns to determine the size and locations where the new cemeteries needs to be developed. The study also indicated where a regional cemetery could be developed, providing burial space for the LDM area

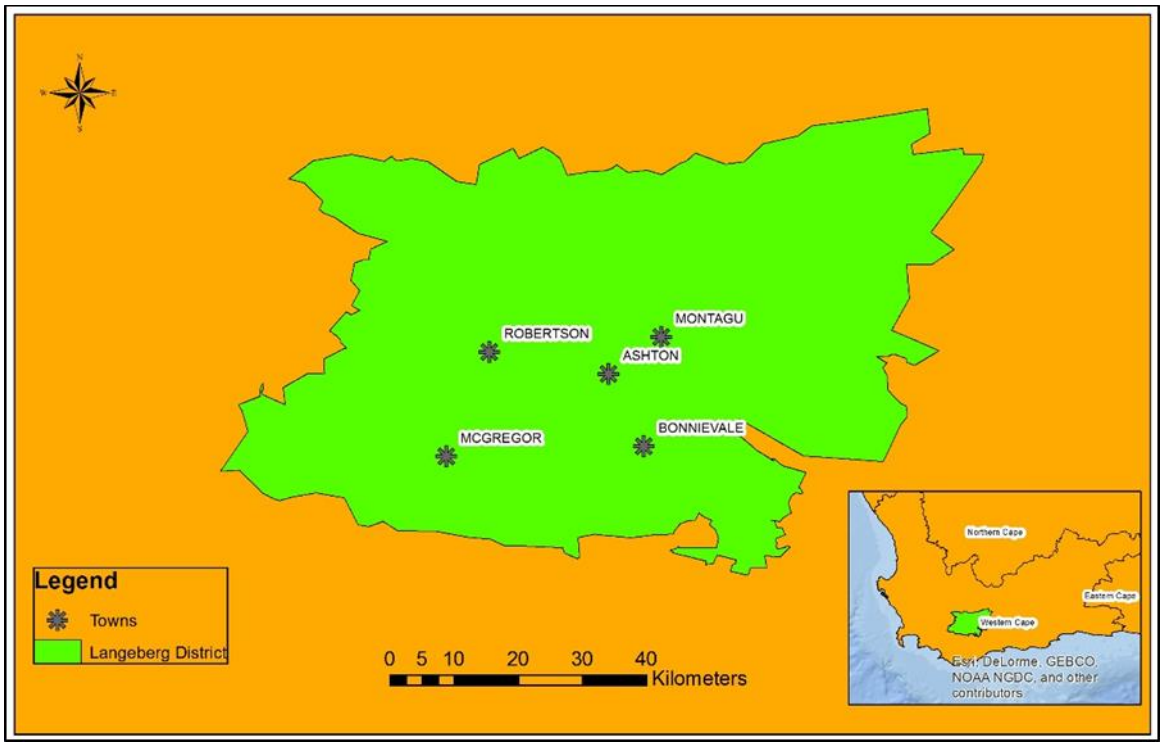

Figure 3.2: Study area (Source: Author, 2017)

3.3 LITERATURE REVIEW

The literature review is divided into three focus areas:

- Theories explaining the concept land-use management, focussing on developing cemeteries.
- Factors influencing developing cemeteries.
- Sustainable management strategies for existing and new cemeteries.

A desktop study approach was used, focussing on these sections, providing appropriate knowledge regarding developing and managing new cemeteries.

3.4 DATA COLLECTION AND DATA SAMPLING

As this study focus on determining, the optimal size of the new cemeteries in the Langeberg Municipality, as well as determining the optimal location based on various factors. The data that was needed to undertake this study is discuss in this section. The variables used in the CSIR cemetery formulas and the factors influencing the location for new cemeteries are discus in depth below.

To determine the space needed for the disposal of the dead is often not focus on as a planning function, but the permanence of allocating these lands to new cemetery use makes it a key aspect to long-range land use planning (Coutts et al 2011). The CSIR, which is a research and development organisation,

which contribute to the improved quality of life of South Africans, have created a calculation formula to determine the amount of land needed for the development for new cemeteries. Table 3.1 below illustrates the various variables, which is needed to use the cemetery formula. Various organisations and the Langeberg Municipality provided the much-needed data (varies in different years) to calculate the amount of land needed to develop new cemeteries in the different towns.

Table 3.1: Variables used in the CSIR formula

Variables use in the CSIR cemetery formula			
Variables	**Owner organisation**	**Year**	**Description of the Data**
Population size of the towns	Statistics South Africa	2011	This data indicates the population size of each town in the Langeberg District.
Total deaths per year	Community Facilities Department of the Langeberg Municipality	2016 - 2017	The Langeberg keeps a record on the amount of deaths in each town, per year. A year usually runs from 1 July each year to 30 June the following year.
Gross area of graves for children	Town Planning Department of the Langeberg Municipality	2017	The Langeberg Municipal By Law relating to the control of cemeteries provide provisions relating the extent of grave plot for a deceased person under the age of nine.
Gross area of graves for adults	Town Planning Department of the Langeberg Municipality	2017	The Langeberg Municipal By Law relating to the control of cemeteries provide provisions relating the extent of grave plot for a deceased person of the age of nine year or older.

Global literature signifies the factors impacting on the location of new cemeteries, such as the land cover of the specific area of the location of rivers, the location of the wetlands, the location of protected areas and the slopes of a specific area (APA 2017; Niţă et al. 2013; SALGA 2016), (DWAF 2015; NIEA 2016) (DWARF 2015; Jonker & Olivier 2012) (DWAF 2015; NIEA 2009; Ward 2016)

(DWAF 2015; NIEA 2016). Table 3.2 b indicates the owner organisations, providing the suitable data, mapping the factors impacting the location of new cemeteries.

Table 3.2 Factors which influence the location for new cemeteries

Various factors which influence the location of new cemeteries				
Factors	**File name**	**Owner organisation**	**Data captured**	**Description of the data**
Land Cover	Sadc_3d_shadef3_vs2_	The GeoTerrimage (GTI)	2014	This layer indicates the Southern African land cover, coverage across South Africa, Swaziland, Lesotho, Mozambique, Botswana, Zimbabwe, and Southern Malawi.
Rivers	NFEPA_Rivers.shp	Council for Scientific and Industrial Research (CSIR)	2011	This GIS layer summarize the river conditions in South Africa.
Wetlands	NFEPA_Wetlands.shp	Council for Scientific and Industrial Research (CSIR	2011	This GIS layer summaries the wetland condition in South Africa.
Protected areas	Protected_Areas_NBA _2011.shp	South African National Biodiversity Institute (SANBI)	2011	This GIS layer consists of polygons of formal protected areas in South Africa
Slope	SUDEM_3319d_3320c_clip	Centre for Geographical Analysis (CGA)	2016	This layer indicates the slopes of the Langeberg area.

After collecting the appropriate data, it was possible to commence the data analysis and process, as explained in Section 3.5.

3.5 DATA PROCESSING AND ANALYSIS

Focusing on the first part of the main aspects of this study, which are determining the amount of land, which is needed to create new cemeteries and the size of these cemeteries, as well as to determine the optimal location after weighting these factors against each other. This section will discuss what types of methods and spatial techniques is used in this study to reach the objectives set out in chapter one of this study. First, the results explain the current cemetery situation, which the LDM is facing. Secondly, the amount of land needed to develop new cemeteries for the different towns in the LDM is discussed in the result. The calculation findings eventually determine the size for the new cemeteries. Thirdly, the results discuss the factors influencing the location of cemeteries, especially focusing on the different towns of the LDM, as well as the regional area. Lastly, all these factor is weighted up against each other by using a MCE tool in order to determine the optimal location of the new cemeteries in the LDM and management and planning strategies is provided.

Current cemetery situation

The current cemetery situation is discuss through visualization of maps. Data on the location and available capacity of the existing cemeteries is gathered from the LDM. These locations of these cemeteries are digitize on google earth to create individual polygons. Using a geo-referencing approach, these polygons are then convert to shape files in order to give them specific coordinates, making it possible to map them in GIS. The findings of the current situation is then elaborated on, through an in depth analysis of the maps which were created, in doing so reaching the second objective of this study.

Calculating the amount of cemetery land needed

This study used the CSIR cemetery formula to determine the required amount of cemetery land needed to develop new cemeteries. It was important to first consult with the LDM in order to gather the appropriate guidelines, which the municipality follows relating to the development of new cemeteries. According to section 13 in the Langeberg Municipal By laws, it stipulates that the provision relating to grave plots be:

"13. (1) The extent of a grave plot for a decease person of the age of nine years or over shall be 2 500mm by 900mm; providing that in the case of a grave plot which is supplied with a berm, the width shall be reduce by 300mm
(2) The extend of a grave plot for deceased person under the age of nine years shall be 1 500mm by 900mm"

As seen above, according to the Langeberg Municipal By law, the total gross area needed of graves for children is 1,35m^2 and the gross area for adults is 2,25m^2 .This required amount of space for grave sites was included in the CSIR cemetery formula to determine the area needed to develop new cemeteries. The specific formula is used in this study is illustrated in Figure 3.3 followed by the explanations of all the symbols use in this formula, as seen below. Step 1, calculates the total deaths; Step 2, calculates the amount of land needed for graves of children; Step 3, calculates the amount of land needed for graves for adults; Step 4, calculates the total area needed to develop new cemeteries for the specific area.

$$\textbf{Step 1: } E = A \times \frac{B}{1000}$$

$$\textbf{Step 2: } X = B1 \times C \times D1$$

$$\textbf{Step 3: } Y = B2 \times C \times D2$$

$$\textbf{Step 4: } Z = X \times Y$$

Figure 3.3: CSIR cemetery formula (Source: CSIR guidelines 2015)

E = Total deaths
A = Total population for which cemetery is planned
B = Average amount of deaths per 1 000 of population per year
B1 = 40% of E (total deaths of children)
B2 = 60% of E (total deaths of people over 10 years of age)
C = a minimum of 30 years

D1 = 1,35 m^2 (gross area of graves for children)

D2 = 2,25 m^2 (gross area of graves for adults)

X = need for graves of children

Y = need for graves for adults

Z = total area needed for cemetery

After the calculations were made which determine the amount of land that is needed to develop new cemeteries, the CSIR guidelines also provided a set of criteria in which the distance of a town of a new cemeteries ought to be developed in. It had an effect on the size of the cemeteries, as these cemeteries will not exceed the size of 8 800m^2 as mentioned in the CSIR guidelines. These cemeteries are classified as a small cemetery, in the CSIR guidelines and is restricted to not be develop further then 2,5km from the urban edge of each town in the LDM. The regional cemetery, which is classified as large cemeteries in the CSIR guidelines, is restricted to be develop in a 30 kilometers buffer zone around the urban edges of the LDM towns. This calculation provided the answer on how many small cemeteries need to be develop around the towns of the LDM. As this formula help the accomplishment of the third objective of this study. The next part of the results discuss the factors which play a role in determining the optimal location for new cemeteries.

Determining the factors which influence the location for new cemeteries

The data process for analysing the factors, which can affect the location of new cemeteries, is mentioned in this paragraph. As previously alluded, this study focus on five factors namely the land cover, the location of rivers, the location of wet lands, where the protected areas are situated, and the suitable slope to develop new cemeteries. Al of these factors are visually illustrated on maps and analyse accordingly. The original land cover dataset provided 72 land cover classes. A dataset class reduction proses was applied in the land cover data set. This proses was use to reduce the amount of classes in this data set, to make the illustration of the different land cover clearer and easier to analyse. Instead of using all the data classes, fifteen main classes was identified to illustrate the land cover. Many classes with the same features was grouped in one land cover class, reducing the original amount of classes. Classes like the urban land cover were such an example of where many land cover with the same feature (like residential land, commercial land, urban open space, everything associated with the urban environment) was group into one class. After the creation of these land cover maps, it was possible to analyse the area of the different town and analyse the different land cover for all these towns, as well as analysing the effect of the land cover on a regional scale for the LDM. The other factors like the location of the rivers, wetlands, protected areas and the slopes were all joint on one map, to analyse the possible location for new local and regional cemeteries in the LDM. These maps

made it possible for reaching the forth objective of this study, which was to determine where the factors are situated, which have an influence on the location of new cemeteries in the LDM.

Identifying the optimal locations for new cemeteries

The illustration of the optimal location for new cemeteries in the LDM is discuss next. It was possible to determine the optimal location by using the appropriate literature on determining the criteria for which the Multi-Criteria Evaluation (MCE) tool will be use to create these locations. The MCE in GIS is concern with allocation of land to suit a specific objective based on a variety of variables (Janke 2010; Lotfi et al 2008). Table 3.3 below illustrated the criteria that was used in this study, in order to determine the optimal location of new cemeteries. The set of criteria was use to identify the class numbers, as seen in the factors illustrated in the Table 3.3 below. All of these factors illustrated below hasa unique class number which was developed by using the set of criteria which made it most suitable, fair suitable, questionable suitable and not suitable.

Table 3.3: Criteria use in the MCE tool

Factors	Suitability	Class number
Land cover: Type of land cover		
Bare none vegetated	Most suitable	3
Cultivated	Not suitable	0
Grassland	Most suitable	3
Low shrubland	Most suitable	3
Mines	Not suitable	0
Mines water permanent	Not suitable	0
Mines water seasonal	Not suitable	0
Plantations	Not suitable	0
Shrubland fynbos	Fair suitability	2
Thicket/ dense bush	Most suitable	3
Urban	Not suitable	0
Water permanent	Not suitable	0
Water seasonal	Not suitable	0
Wetlands	Not suitable	0
Woodland/Open bush	Most suitable	3

Rivers: Distance from the river buffer zones		
Greater than 500m	Most suitable	3
400m – 500m	Fair suitability	2
300m – 400m	Questional suitability	1
Closer than 300m	Not suitable	0
Wetlands: Distance from wetlands buffer zone		
Greater than 50m	Most suitable	3
Closer than 50m	Not suitable	0
Protected areas: Location		
In a formal protected area	Not Suitable	0
In an informal protected area	Questional suitability	1
Outside a protected area	Most Suitable	3
Slopes: Gradient of the slopes		
Below 2^{o}	Not suitable	0
Between $2^{o} – 9^{o}$	Most suitable	2
Greater than 9^{o}	Not suitable	0

The land cover (lc_poly.shp), rivers (rivers.shp), wetland (wetlands.shp) and protected area (protected_area.shp) factors was used to build the MCE tool, which is indicated in Figure 3.4 below. The tool weighted these factor against each other and merge the findings together to provide the visualization of the potential optimal locations for new cemeteries. The calculated field tool was used in this MCE to calculate the different land cover types according to their class number. The multiple ring buffer tool is used for the create buffers around the rivers and wetlands to calculate the different areas according to the criteria created to determine the optimal location for new cemeteries. All the calculated fields of all the factors were merge to create the maps which indicated the suitable locations for new cemeteries in the LDM.

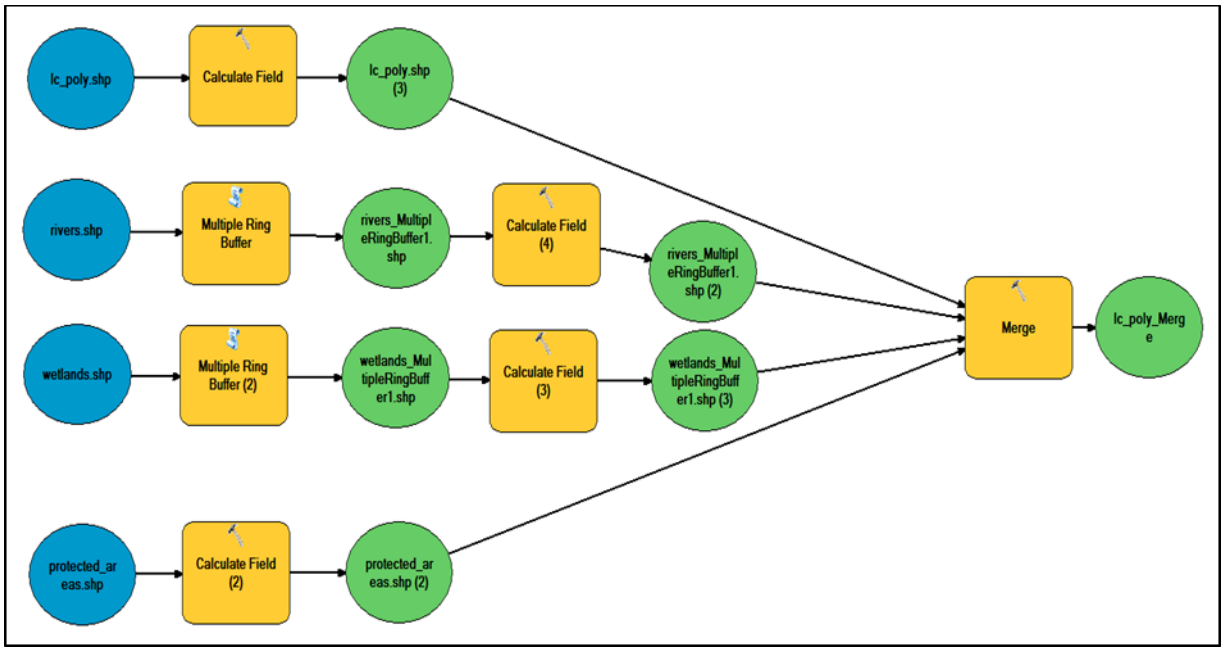

Figure 3.4: MCE tool used to determine the optimal location for new cemeteries

The slopes of the LDM was develop on a separate layer, which was placed on top of the MCE result layer. The slopes layer indicated the not suitable areas and the suitable areas was transparent in order to make the result visible of the MCE. Table 3.4 below explain how the results were illustrated on the maps. This data processing and analysis made it possible to reach the fourth objective of this study, which is finding the optimal location for new cemeteries in the LDM.

Table 3.4: The criteria use to illustrate the optimal location for new cemeteries

Suitability	Colour
Not suitable	
Questional suitability	
Fair suitability	
Most suitable	

In the final section of the results, the sustainable planning and management strategies for the existing and new cemeteries in the LDM are discuss. These strategies are developed according to all the specific factors, which is identified in the results on local level as well as on regional level. These strategies is gathered from suitable literature and provide planning measure in which the LDM should take cognize of when developing these cemeteries. This chapter makes it possible to reach the final objective of this project, which is providing the LDM sustainable planning and management strategies for the existing and new cemeteries.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 CURRENT SITUATION FOR THE LANGEBERG MUNICIPALITY

The availability of land to develop new cemeteries are becoming a big concern for urban planners. This section will shed some light on the current capacity situation of the existing cemeteries in the Langeberg Municipality. The Langeberg Municipality consist of five major towns which are McGregor, Bonnievale, Ashton, Montagu and Robertson. Currently there are a total of seventeen municipal owned cemeteries identified across the Langeberg municipal district. While only thirteen cemeteries are in use, as the other four cemeteries are full to capacity as seen in Table 4.1. Data provided by the LDM is use to discuss the current situation of these cemeteries and how many burial space is left. The goal of this section is to illustrate the cemetery challenge of the LDM, in which the current situation of McGregor are discussed, followed by the cemetery situation in Bonnievale. Ashton is discussed next, followed by the town of Montagu's discussion. Lastly Robertson's cemetery situation is discussed, followed by a conclusion for this section.

Table 4.1: Current cemetery situation in the Langeberg District

Number	Name	Location	Capacity usage	Months/ Years left before capacity is reached
1	Tindall Street cemetery	McGregor	65% used	Use for another 4 years
2	New Cross Street cemetery	Bonnievale	89% used	Use for another 2 years
3	Milner Street cemetery	Bonnievale	99% used	Use for another 3 months
4	New Town cemetery	Bonnievale	12% used	Use for another 4 years
5	Old Town cemetery	Bonnievale	92% used	Use for another 1 year
6	Conradie Town cemetery	Ashton	95% used	Use for another 3 months
7	Cogmanskloof cemetery	Ashton	100% used	No more capacity left
8	Silo cemetery	Ashton	55% used	Use for another 2 years
9	Zolani Old cemetery	Ashton	100% used	No more capacity left
10	Zolani New cemetery	Ashton	40% used	Use for another 4 years
11	Park Street A & B cemetery	Montagu	95% used	Use for another 3 months
12	Golf course cemetery	Montagu	95% used	Use for another 3 months
13	Ashbury Old cemetery	Montagu	100% used	No more capacity left

14	Ashbury New cemetery	Montagu	20% used	Use for another 4 years
15	White Street cemetery	Robertson	60% used	Use for another 1 year and 6 months
16	Droeheuwel cemetery	Robertson	100% used	No more capacity left
17	Nqkubela cemetery	Robertson	50% used	Use for another 4 years

(Source: Langeberg District Municipality 2017)

McGregor holds four cemetery areas, situated at the end of Tindall Street at the northern part of the town and is the only town in the LDM which do not consist of a cemetery which is at full capacity. (Figure 4.1). Although Bonnievle (Figure 4.2), Ashton (Figure 4.3), Montagu (Figure 4.4) and Robertson (Figure 4.5) consist of cemeteries which have a capacity usage of more than 95%, is it Montagu which indicates the worst cemetery situation of all the town in the LDM (Table 4.1). Montagu town comprises four cemeteries (Figure 4.4). One of those cemeteries already reached its full capacity, whilst from the remaining three cemeteries, only one have the available capacity space to be used for more than a year. The cemeteries situated in Montagu indicate: The Park Street A & B cemetery - this cemetery is situated in in the centre of the town of Montagu and 95% of the space was used. It is predicted that this cemetery will only be used for another year before it will reach its full usage capacity; the Golf Course cemetery, situated near the Montagu golf course has used 95% of capacity and it is predicted that this cemetery will only be used for another three months before reaching its full capacity; the Ashbury Old cemetery reached its full capacity of 100%, with no more space for new burials; the Ashbury New cemetery used 40% of its capacity. It is predicted that this cemetery will be used for another four years before it will reach its full capacity (Table 4.1). The current usage capacity for three of the four cemeteries exceeds 95% and the prediction for future usage for the Asbury New cemetery could also decrease if no new cemeteries are established. This will become the only cemetery where space will be available for new burial grounds. It is therefore important for the Langeberg Municipal urban planners to develop new cemeteries first in the Montagu area, before developing the new cemeteries in the other towns of the LMD.

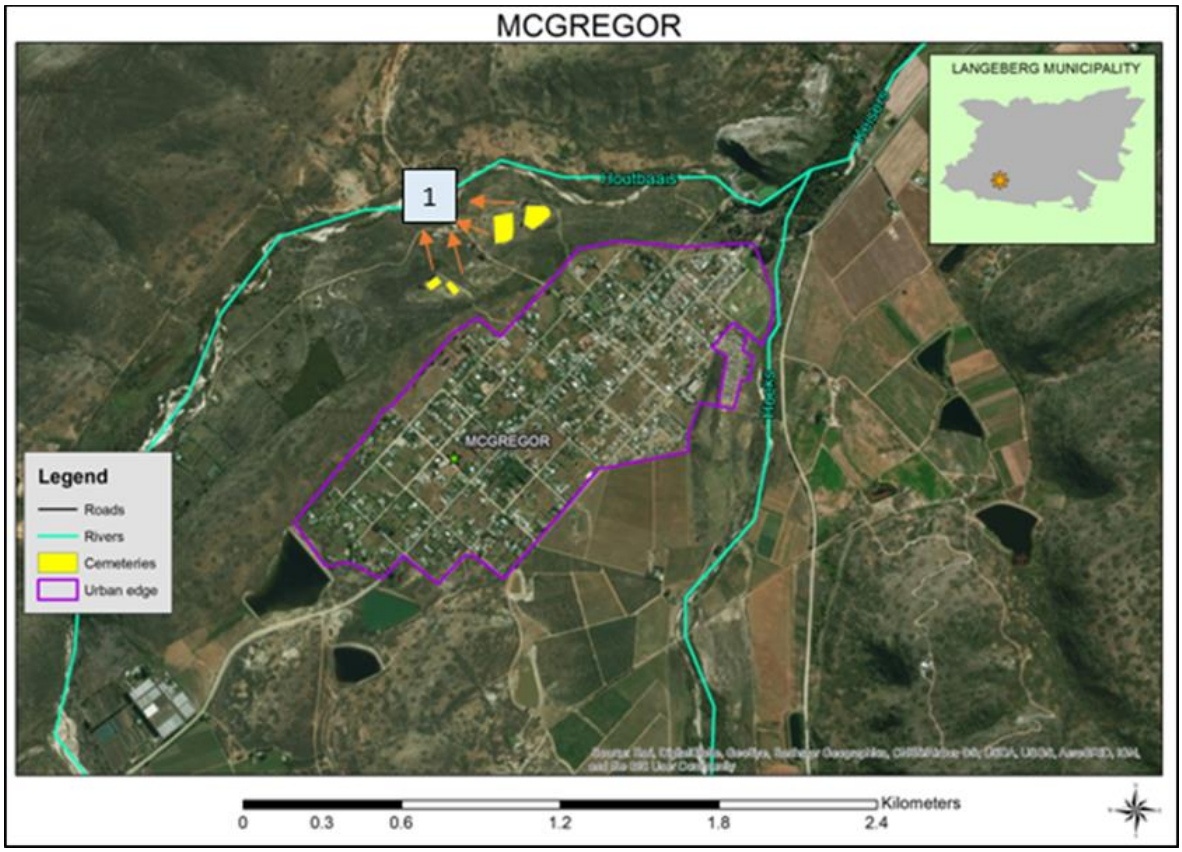

Figure 4.1: Location of current cemeteries in McGregor

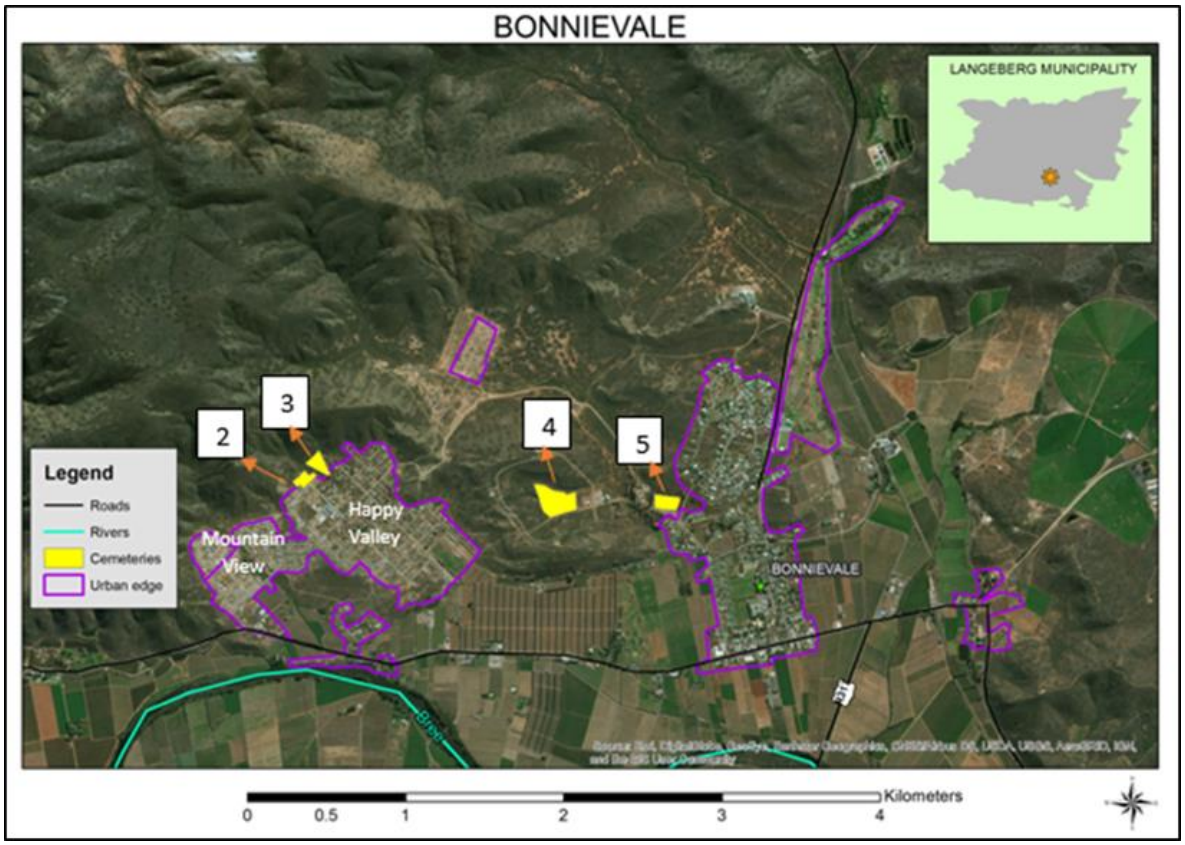

Figure 4.2: Location of current cemeteries in Bonnievale

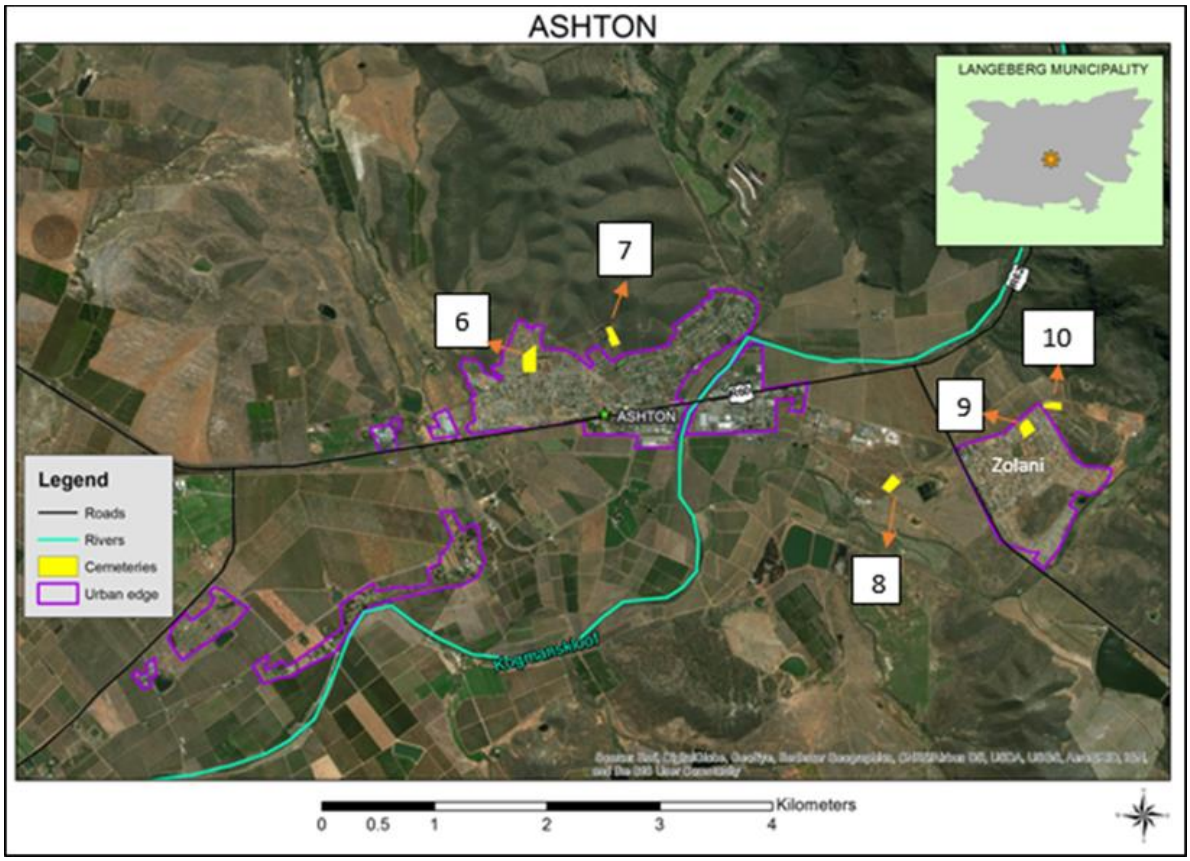

Figure 4.3: Location of current cemeteries in Ashton

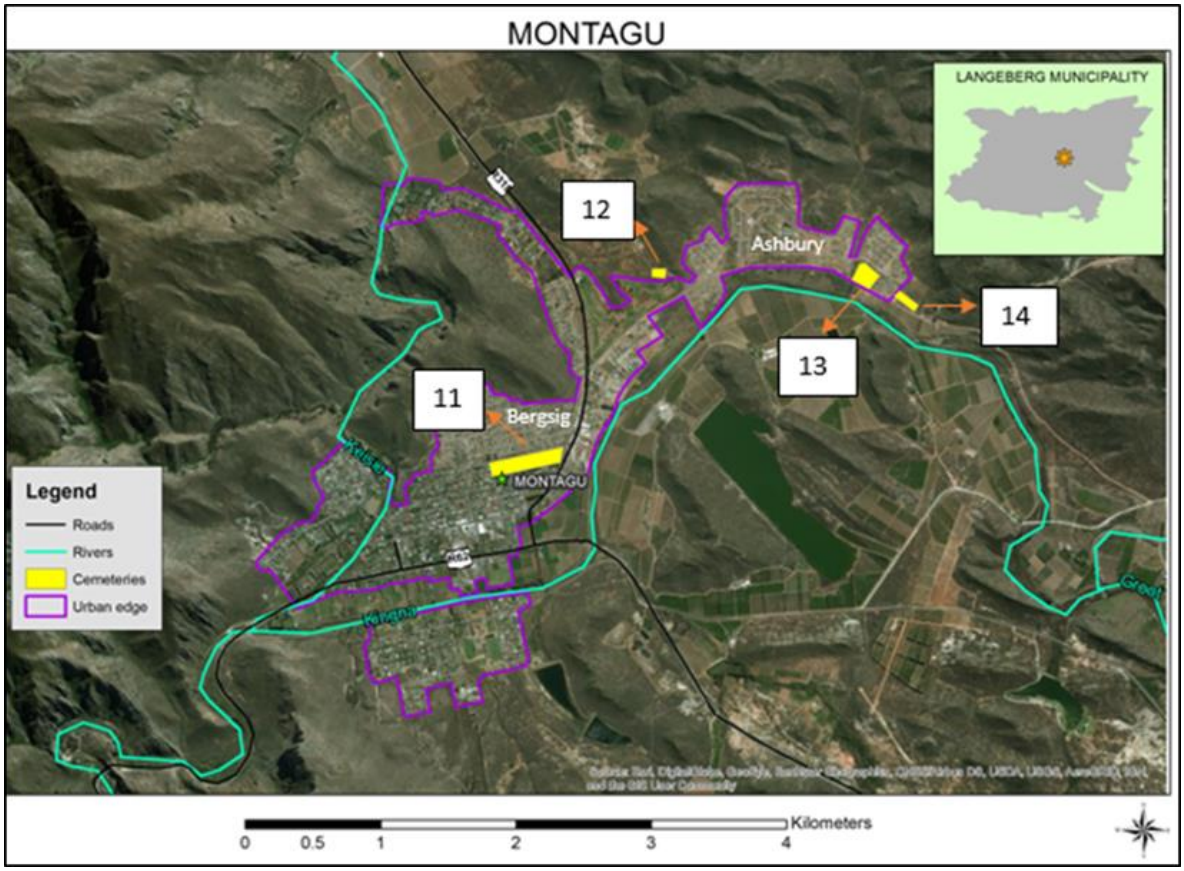

Figure 4.4: Location of current cemeteries in Montagu

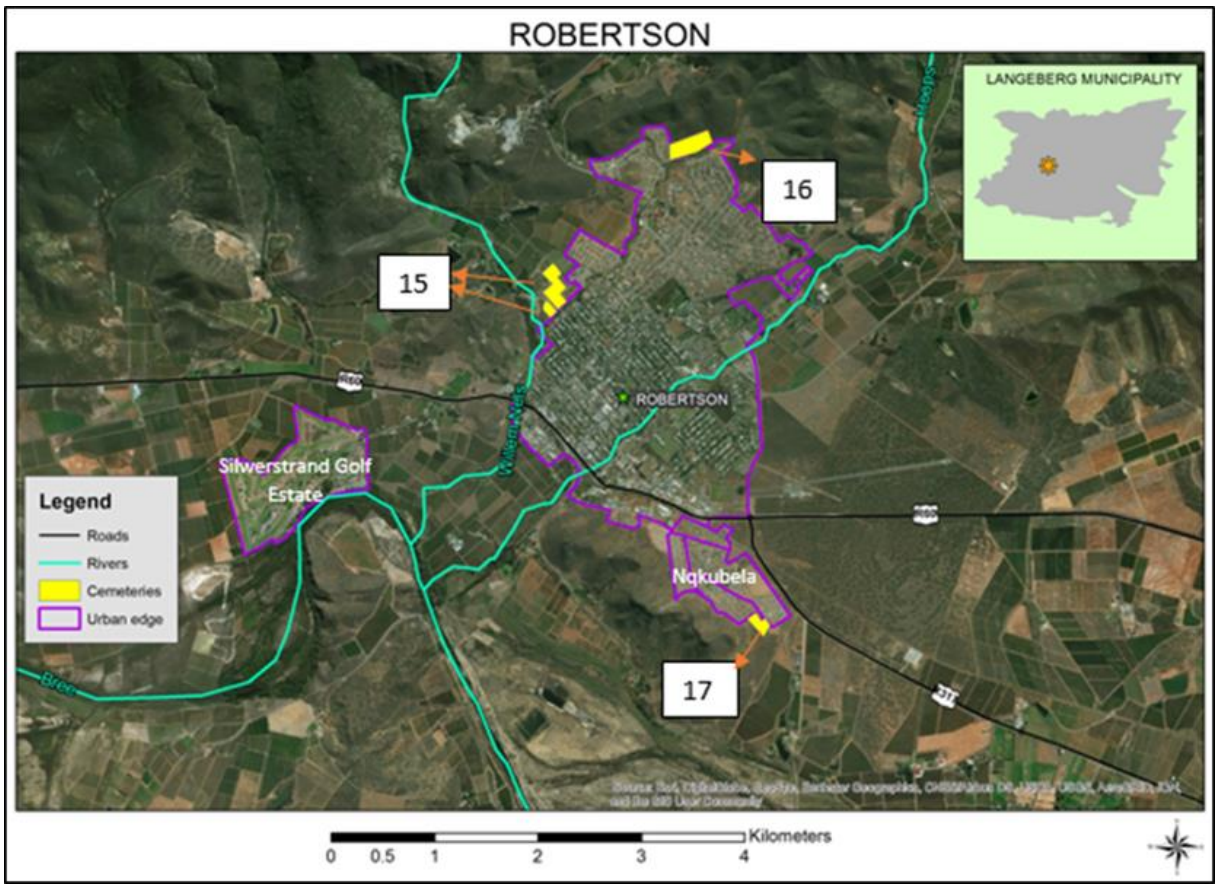

Figure 4.5: Location of current cemeteries in Robertson

4.2 DETERMINING THE CEMETERY SIZE OF EACH TOWN IN THE LANGEBERG MUNICIPALITY

As mentioned in Chapter 3, this project made use of the CSIR cemetery formula, which was published in the CSIR guidelines for the provision of social facilities in South African Settlements. This formula focused on different aspects like total population of each town, which was gathered from the 2011 census data, and the amount of deaths experienced per year in a specific town to determine exactly how big each cemetery for each town ought to be.

There are five towns situated in the Langeberg District and each town require a different amount of available land for new cemeteries. The calculations of each town is calculated from the smallest town to the biggest. There is also a calculation to determine how much land is needed to develop a regional cemetery. The small town of McGregor with a population of 3 125 people (Census 2011) is calculated first, followed by the town of Bonnievale with a population of 9 092 people (Census 2011), Ashton

is calculated then with a population of 13 325 people (Census 2011), the second largest town in the Langeberg Municipal District with a population of 15 176 people (Census 2011) is Montagu which is calculated, then the largest town in the Langeberg Muncicpality is Robertson with a population of 27 715 people (Census 2011) is calculated. The Langeberg regional cemetery is calculated lastly, this calculation takes all the five town's population into account and calculates the land needed to develop new cemeteries for the population of 68 433 people.

The results for the small town of McGregor indicates that 1 468,125375 m2 of land is needed to bury the death of the children. The total land needed to bury the people older than ten years is 3 670,3125 m^2. Finally after calculating all the steps, the total amount of land needed to develop new cemeteries in McGregor are 5 139 m^2 (figure 4.6). This amount of land, which is calculated for McGregor, would be enough to sustain the amount of deaths in this area for the next 30 years to come.

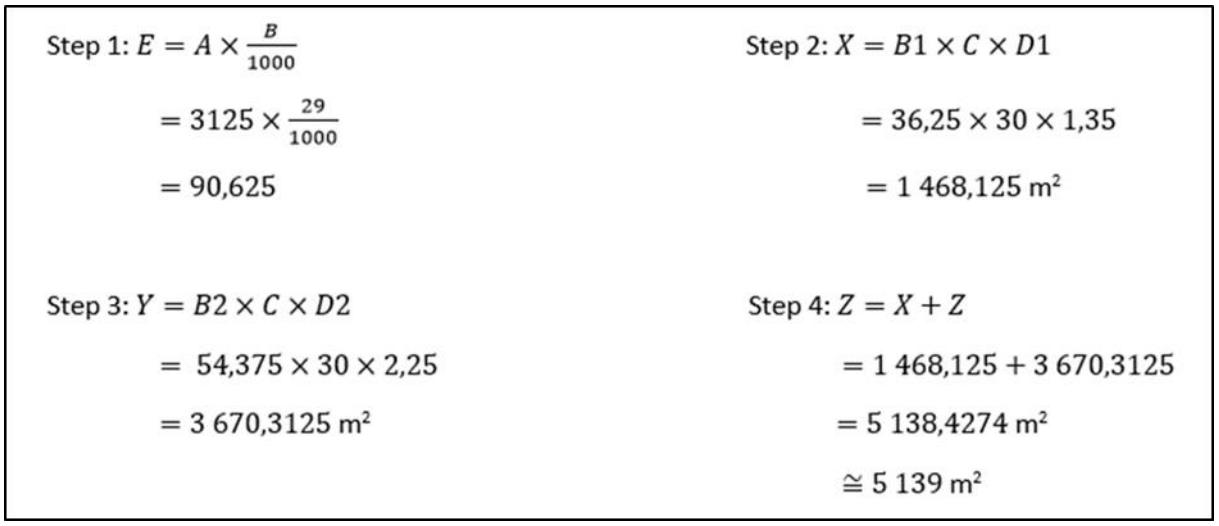

Figure 4.6: Cemetery calculation for McGregor

The results for the town of Bonnievale indicates that 20 473,3656 m^2 of land is needed to bury the children. The land needed to bury the people older than ten years is 51 183,414 m^2. The total area which is needed to develop new cemeteries for the town of Bonnievale are 71 657 m^2 (figure 4.7).

Step 1: $E = A \times \frac{B}{1000}$

$= 9\,092 \times \frac{139}{1000}$

$= 1\,263{,}788$

Step 2: $X = B1 \times C \times D1$

$= 505{,}5152 \times 30 \times 1{,}35$

$= 20\,473{,}3656\ m^2$

Step 2: $Y = B2 \times C \times D2$

$= 758{,}2728 \times 30 \times 2{,}25$

$= 51\,183{,}414\ m^2$

Step 4: $Z = X + Y$

$= 20\,473{,}3656 + 51\,183{,}414$

$= 71\,656{,}7796\ m^2$

$\cong 71\,657\ m^2$

Figure 4.7: Cemetery calculation for Bonnievale

It is calculated that Ashton will need 21 154,77 m^2 for the burials of children. While the land needed to bury the people older than 10 years, are 52 886,925 m^2. The total amount of land needed to develop new cemeteries for the town of Ashton is calculated that 74 042 m^2. The total land needed to develop new cemeteries will be enough burial place for the people of Ashton for the next 30 years (figure 4.8).

Step 1: $E = A \times \frac{98}{1000}$

$= 13\,325 \times \frac{98}{1000}$

$= 1\,305{,}85$

Step 2: $X = B1 \times C \times D1$

$= 522{,}34 \times 30 \times 1{,}35$

$= 21\,154{,}77\ m^2$

Step 3: $Y = B2 \times C \times D2$

$= 783{,}51 \times 30 \times 2{,}25$

$= 52\,886{,}925\ m^2$

Step 4: $Z = X + Y$

$= 21\,154{,}77 + 52\,886{,}925$

$= 74\,041{,}695\ m^2$

$\cong 74\,042\ m^2$

Figure 4.8: Cemetery calculation for Ashton

Montagu is the second largest town in the LDM, and it is calculated that 24 955,3224 m^2 of land is needed for burial space to bury the children. The amount of space which is needed to bury the people older than 10 years, is 62 653,5 m^2. In total, the amount of land needed to develop new cemeteries in the town of Montagu over a period of 30 years are 87 609 m^2, as seen in step four (figure 4.9).

Step 1: $E = A \times \frac{B}{1000}$

$= 15\,176 \times \frac{102}{1000}$

$= 1\,547{,}952$

Step 2: $X = B1 \times C \times D1$

$= 619{,}1808 \times 30 \times 1{,}35$

$= 24\,955{,}3224\ m^2$

Step 3: $Y = B2 \times C \times D2$

$= 928{,}2 \times 30 \times 2{,}25$

$= 62\,653{,}5\ m^2$

Step 4: $Z = X + Y$

$= 24\,995{,}3224 + 62\,653{,}5$

$= 87\,608{,}8224\ m^2$

$\cong 87\,609\ m^2$

Figure 4.9: Cemetery calculation for Montagu

Robertson is the largest town in the LDM with a population of 27 715 people 111 796,767 m^2 of burial land is needed to bury the children. The space which is needed to bury the people older than 10 years, are 279 491, 9175 m^2. Thus the total of land which is needed for new cemeteries, over the period of 30 years, are 391 289 m^2 (figure 4.10).

Step 1: $E = A \times \frac{B}{1000}$

$= 27\,715 \times \frac{249}{1000}$

$= 6\,901{,}035$

Step 2: $X = B1 \times C \times D1$

$= 2\,760{,}414 \times 30 \times 1{,}35$

$= 111\,796{,}767\ m^2$

Step 3: $Y = B2 \times C \times D2$

$= 4\,140{,}621 \times 30 \times 2{,}25$

$= 279\,491{,}9175\ m^2$

Step 4: $Z = X + Y$

$= 111\,796{,}767 + 279\,491{,}9175$

$= 391\,288{,}6845\ m^2$

$\cong 391\,289\ m^2$

Figure 4.10: Cemetery calculation for Robertson

The calculation for determining the amount of land needed to develop regional cemeteries is calculated in this paragraph. The amount of land needed to bury the children in the Langeberg District are 684 015,2082 m^2. The amount of land needed to bury the people older than 10 years, are 1 710 038,0205 m^2. The total amount of land needed to develop new regional cemeteries for the Langeberg District are 2 394 054 m^2 (figure 4.11).

Step 1: $E = A \times \frac{B}{1000}$

$= 68\,433 \times \frac{617}{1000}$

$= 42\,223{,}161$

Step 2: $X = B1 \times C \times D2$

$= 16\,889{,}2644 \times 30 \times 1{,}35$

$= 684\,015{,}2082\ m^2$

Step 3: $Y = B2 \times C \times D2$

$= 25\,333{,}8966 \times 30 \times 2{,}25$

$= 1\,710\,038{,}0205\ m^2$

Step 4: $Z = X + Y$

$= 684\,015{,}2082 + 1\,710\,038{,}0205$

$= 2\,394\,053{,}2287\ m^2$

$\cong 2\,394\,054\ m^2$

Figure 4.11: Cemetery calculation for the Langeberg District

It is important to remember that this calculation provided the amount of land needed to develop new cemeteries, and as mention in Chapter 3, the CSIR guidelines provide the criteria for the specific size of a small cemetery and its cemetery distance buffer zone. After the total amount of cemetery land needed for each town is calculated, it is possible to determine the amount of new cemeteries for each town. However, before the amount of cemeteries are determine it is important to find the optimal location for these new cemeteries. The following section focus on the factors, which can have an impact on the location of new cemeteries.

4.3 FACTORS THAT INFLUENCE THE DEVELOPMENT OF NEW CEMETERIES IN THE LANGEBERG DISTRICT

In the literature there are many factors described which could affect the location of new cemeteries. This study however managed to focus on four important factors that definitely had an impact on determining the location for possible new cemeteries in the LDM. These factors are land cover, rivers and wetlands, protected areas and the slopes of a specific area. This section discussed these factors in depth focusing on every town in the LDM, also focusing on these factors on a regional level to determine what impact it could have on the development of regional cemeteries.

4.3.1 LAND COVER

Different land cover/land use types can play a role on determining the location for new cemeteries. The original set of data had seventy-two different land cover/ land use classes, but for the purpose of this study, some of these classes were combine to develop fifteen different classes in order to better illustrate the different land uses in the different towns of the LDM. The land cover for each town in the Langeberg District is discuss in the following paragraph, as this will visually make it possible to identify where new cemeteries could be develop according to the type of land cover.

As indicated in Figure 4.12, McGregor is mainly surrounded by shrub land fynbos land cover, wetlands and plantations, which is situated at the north western side of the urban edge of the town as well as a large cultivated area on the eastern side of the town. These areas however will not be suited for developing new cemeteries. The land needed to develop new cemeteries in the town of McGregor are not as big comparing to the other towns of the Langeberg District and the southern peripheral area outside of the urban edge are bare non-vegetated land cover patches, which can be a suitable land cover for the purpose of new cemeteries.

The land cover at the town of Bonnievale indicates that there is a large cultivated area, which stretches from the eastern to the western side of the map, covering the southern area of the peripheral area of the town, as seen in Figure 4.13. It is mention in the SDF of the Langeberg that this cultivated area is one of the most fertile areas in the Langberg area (SDF 2016). It is of outmost importance to protect these cultivated areas (vineyards), as this is use for intensive commercial farming. In addition, it is evident that the dominant land cover in the surrounding area of Bonnievale are the shrub land fynbos land cover. However, it is noted that many patches of thicket/dense bush and woodland/open bush are also scattered in this area, and these will be suitable land covers for the development of new cemeteries in the surrounding area of Bonnievale.

In Ashton, it is clear that the cultivated area is the largest land cover of this town. This cultivated area stretches from the south western to the north eastern part of the peripheral land alongside the wetland land cover, as seen in figure 4.14. Shrub land fynbos is the other major land cover of this area. According to the land cover situation in Ashton, it would be suggested that some of these shrub land fynbos, next to the patches of the thicket/dense bush land covers could also be used to developed new cemeteries, in order to reach the amount of land needed for new cemeteries.

Montagu does not have the cultivated land cover as the dominant land cover, but instead it is the thicket/dense bush land cover. There are also big patch of grassland and low shrub land scattered around the peripheral area of Montagu. However, Montagu is situated in a valley and is surrounded by the Langeberg mountain range, this can have an effect on the available land to develop new cemeteries, and the abundance of land available as indicated in figure 4.15 could be misleading in the actual land that is available for new cemeteries in this area. Good planning governance is needed in order to reach the amount of land for the development of new cemeteries in the town of Montagu.

Being the largest town in the Langeberg District, Robertson have the biggest population size which contributed to the amount of land needed to develop new cemeteries in this area, as calculated in the previous section. The cultivated land cover is the largest land cover of this area, and no cemeteries can be develop in these areas. However, large patches of thicket/dense bush are also available in the peripheral area of Robertson. As seen in figure 4.16 the suitable land cover to develop new cemeteries are available in the peripheral area but it would be suggested, just like in the case of Ashton, that in some areas shrub land fynbos would also be use in order to reach the amount of area needed to develop new cemeteries in Robertson.

On a regional scale, the land cover of the Langeberg District indicates that a large cultivated area is situated between Robertson and Ashton. Shurbland fynbos are the dominant land cover for the Laneberg District as seen in figure 4.17, this land cover is suitable for the development of new regional cemeteries. It is just important for the town planners of the LDM to identify a large enough area to meet the required amount of land for new cemeteries.

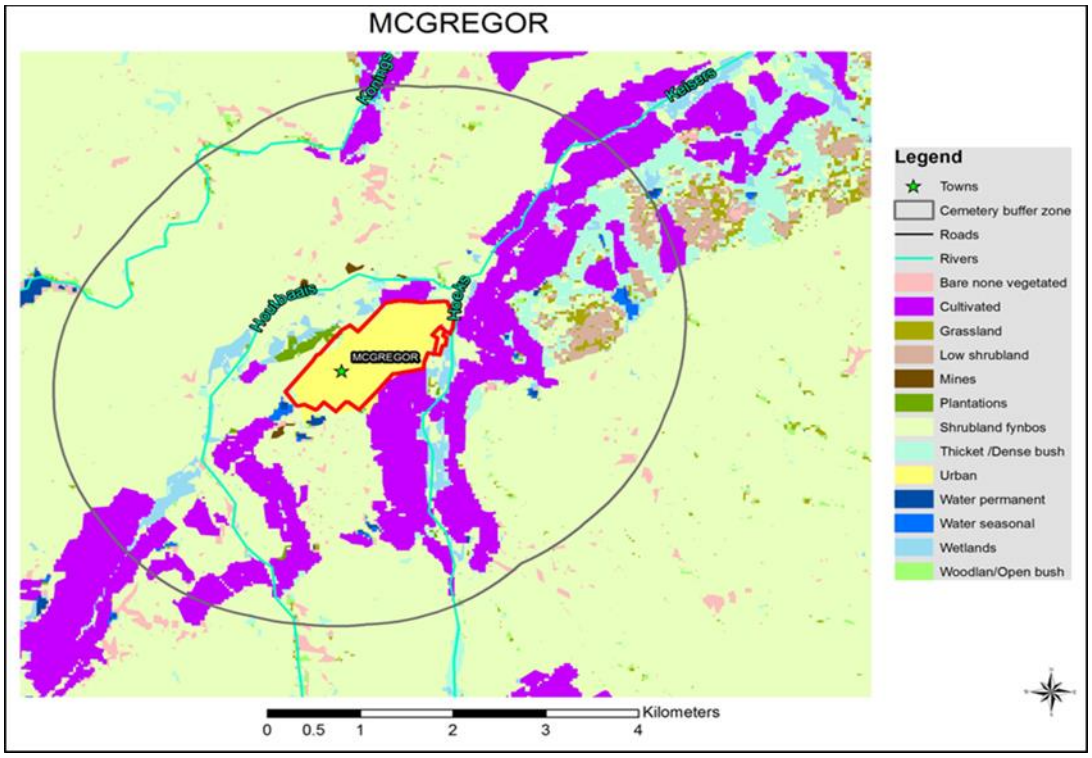

Figure 4.12: Land cover situation in McGregor

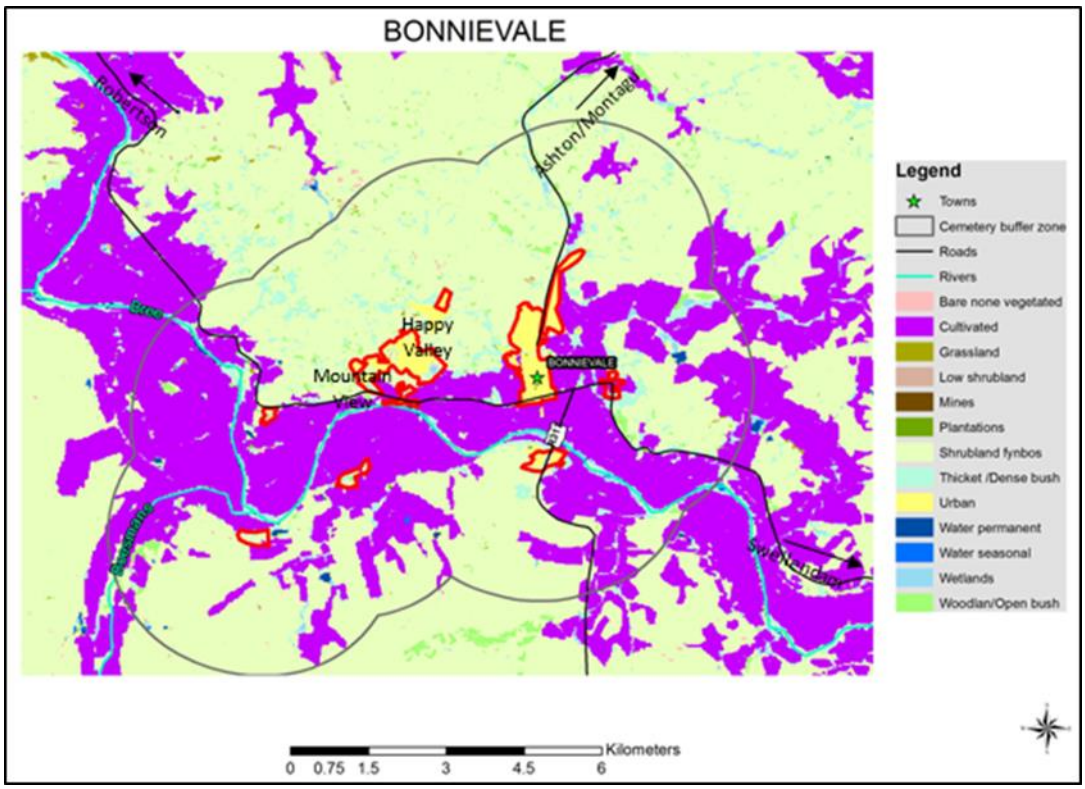

Figure 4.13: Land cover situation in Bonnievale

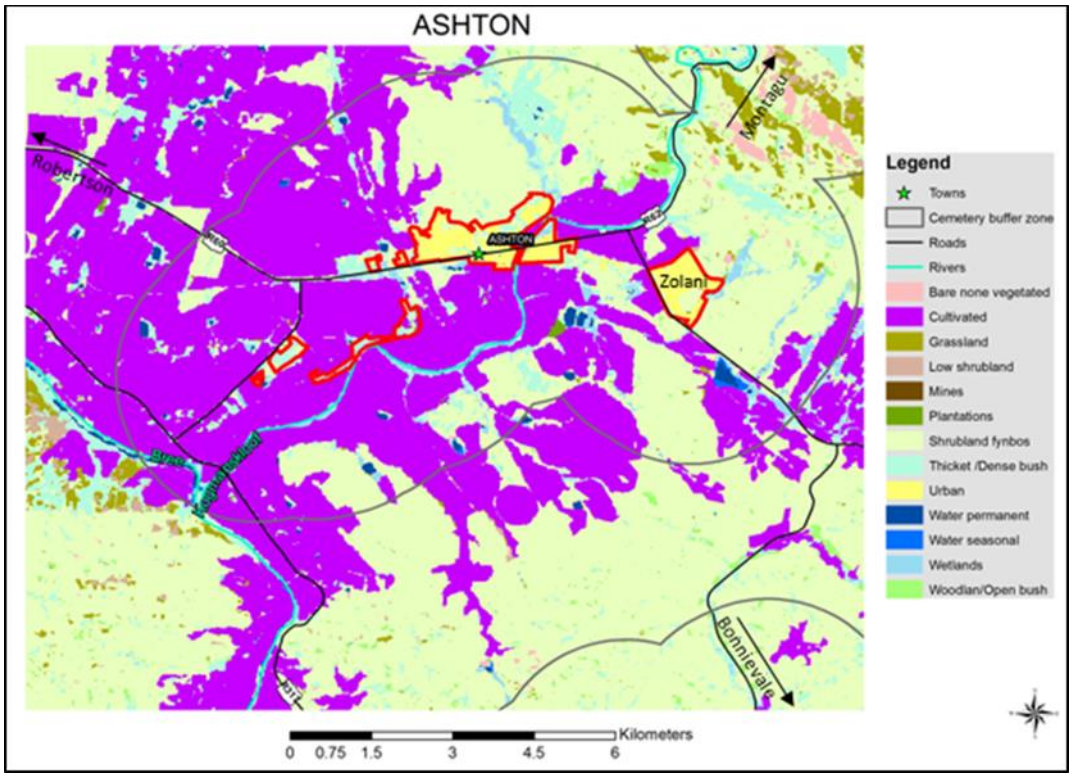

Figure 4.14: Land cover situation in Ashton

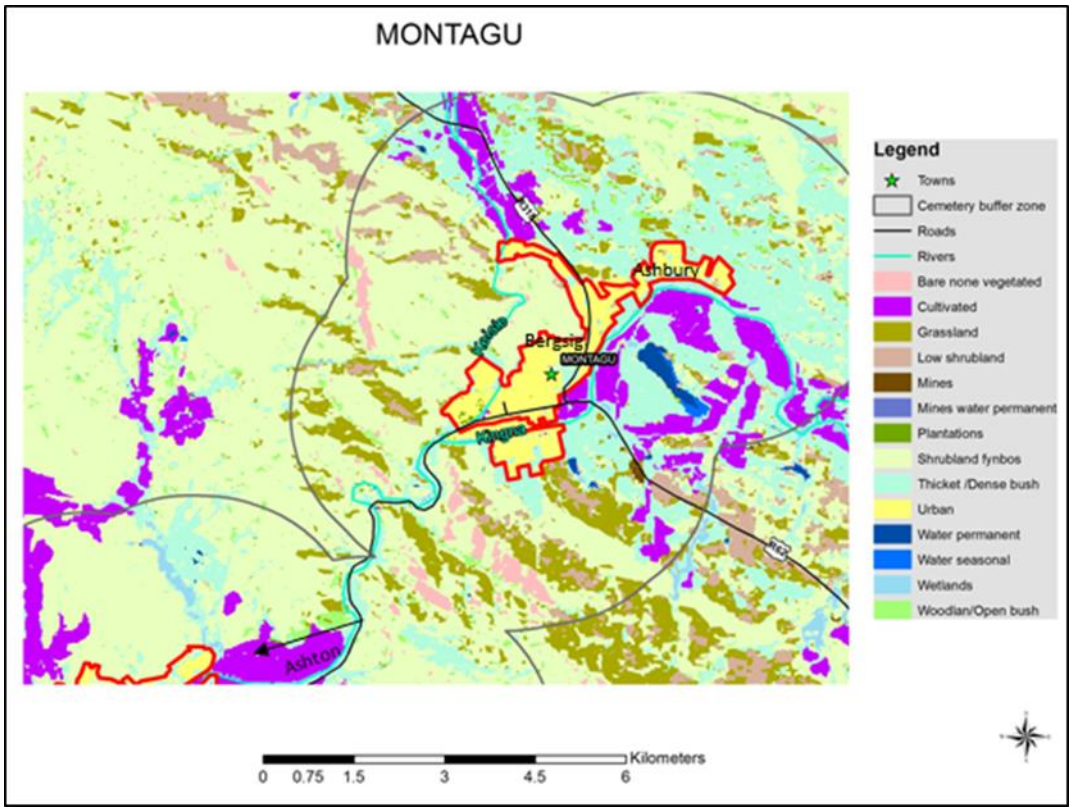

Figure 4.15: Land cover situation in Montagu

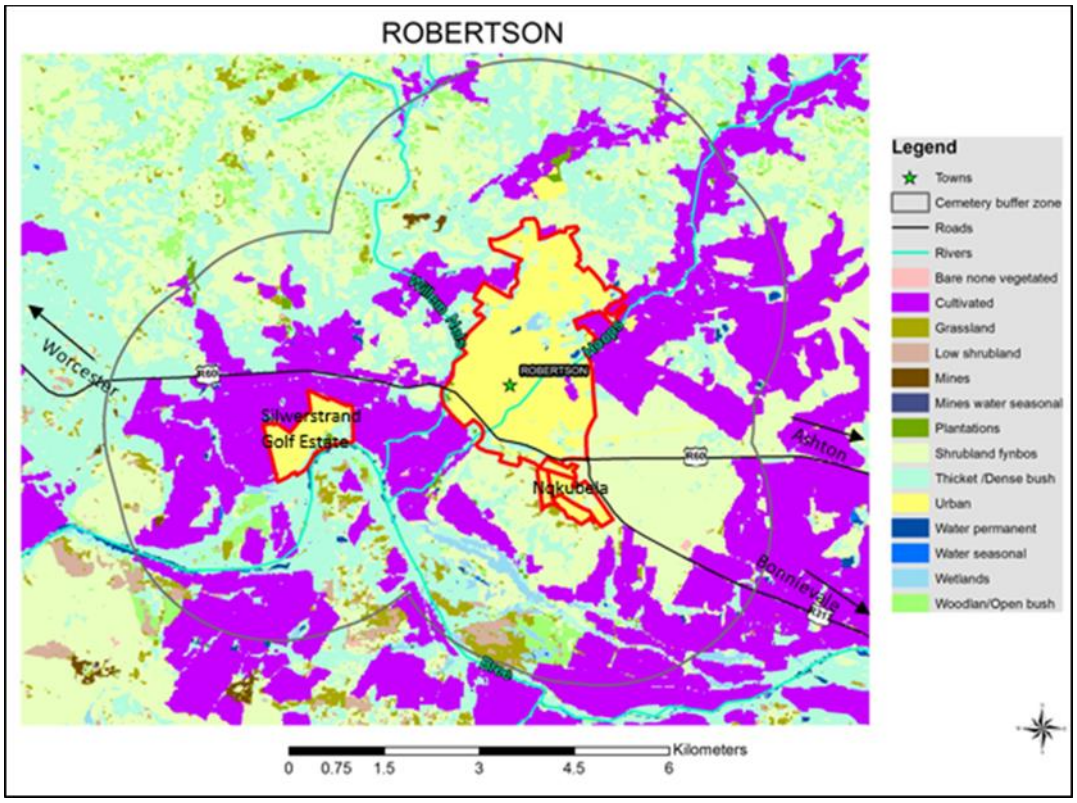

Figure 4.16: Land cover situation in Robertson

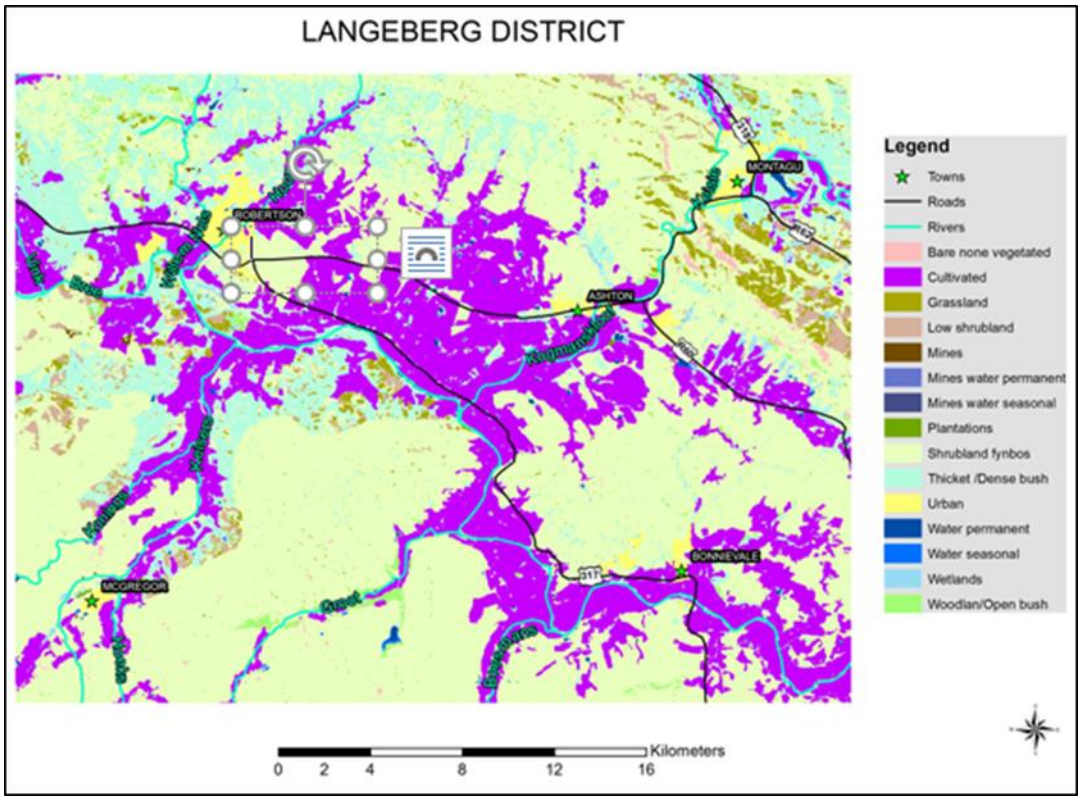

Figure 4.17: Land cover situation in the Langeberg District

4.3.2 RIVERS AND WETLANDS

This section will exclusively just focus on the wetlands and rivers of the LDM. According to a criteria list which was created by the Department of water affairs, new cemeteries should not be developed within 300m of any rivers as these new cemeteries could polite the water (DWAF 2015). According to previous studies in the literature, it was also mentioned that no new cemeteries should be develop within 50m of any watercourse such as a wetland. This section will discuss where these rivers and wetlands are situated in the different towns of the Langeberg District, as this could contribute to identify the optimal location for new cemeteries.

As indicated in figure 4.17 a large wetland strip is covering the northern, eastern and western peripheral land of the town of McGregor. The wetland is situated around the the Houtbaais river which is situated at the north western part of the peripheral land near McGregor and the Hoeks river which flows past the eastern part of the urban edge of McGregor and could definitely have an impact on where to create new cemeteries. When focusing on the town of McGregor one could see that the southern part of the peripheral land near MacGregor have open patches where no wetlands or rivers are situated, making this the perfect location for potential new cemeteries.

Although Bonnievale are situated near the Bree river, it is only the southern part of the urban edge which could be affected by the river as seen in figure 4.18. A small wetland strip is situated on the eastern urban edge of Bonnievale, which could affect the development of new cemeteries, however large open space is available at the northern peripheral land and it could be the optimal location for new cemeteries at Bonnievale.

Ashton is situated near the Kogmanskloof River as seen in figure 4.19. Unlike Bonnievale, Ashton have many wetland patches scatters all over the peripheral land outside the urban edge. All these wetland patches and the Kogmanskloof River which flow through Ashton, can have an impact on where to develop new cemeteries for the town of Ashton

Montagu is also situated near the Kogmanskloof River and Kinga river, as seen in figure 4.20. Patches of wetland areas is scattered over the peripheral area, but because of the small size of these wetlands, it should not be too difficult to determine new cemetery areas for the town of Montagu. There is especially a large open area south from the urban edge and the potential new cemeteries could be develop here.

Robertson is situated near the Bree River, which flow past the southern part of the town's urban edge. The Hoops river and Willem Nels river also flows through the town and would definitely have an impact on determining where the new cemeteries should be situated. There is a large wetland situated around the Bree rivier and small patches of wetland, which is scattered around the western and northern peripheral land, outside the urban edge of Robertson as seen in figure 4.21. However, large open areas are also visible in this area and the potential of new cemeteries could be develop here. As mentioned in the previous section, Robertson requires a large amount of new cemetery land, and a good cemetery planning proses is needed from Langeberg Municipality.

When determining where the optimal location would be to develop regional cemeteries, it is important to focus on the Langeberg on a regional level as seen in figure 4.22. The Langeberg has a large amount of rivers, which flows through the district, as well as many patches of wetland, which is situated near these rivers. The main rivers which could potentially have an impact on where to develop new regional cemeteries are; the Bree river which flow through the center of the Langeberg district; The Kogmanskloof river which could affect the location of a regional cemetery in the Ashton and Montagu area. In addition, the Konings river and Keisers river can have an impact on determining a regional cemetery in the Robertson and McGregor area. There are large areas between Ashton and Robertson, which could potentially be the location for new regional cemeteries.

4.3.3 PROTECTED AREAS

Protected areas and nature reserve areas need to be manage in a sustainable manner. It is important for the Municipal of the Langeberg to protect these areas and to ensure that these areas will not be harm, as this is areas of indigenous and endangered fynbos species. The Langeberg District is situated in a fynbos-rich area, and the protection of this indigenous plant species should be a priority to the municipality. This part of the section will focus on the nature reserve areas which is situated in the Langeberg District. The data that was provided by the South African National Biodiversity Institute indicated that all the nature reserve areas situated in the Langeberg District are formal nature reserves, which indicates that no cemeteries should be, develop here. As seen below a large nature reserve region is situated in the north eastern part of the Langeberg district. This nature reserve will only have an effect on the towns of Ashton and Montagu, and could have an impact on the location of new cemeteries in these towns. The specific nature reserves located in the towns of Ashton and Montagu will be discussed in the next paragraphs, in which after the whole of the Langeberg will also be discuss to determine where the optimal locations could be for the development of regional cemeteries.

The Langeberg-Wes Mountain Catchment area is situated north-east from Ashton. This area should be taken notice of when determining the new cemeteries, especially in the northern urban edge of Zolani. As mentioned in this study, the existing New Zolani cemetery were develop on the border of this protected area. It could be argue that this cemetery can be extended to the south east, as a large open area is visible, as seen in figure 4.19. The southern and western peripheral land of Ashton is not affected by this protected area and should not influence the determining of new cemeteries.

Montagu is situated close to the Langeberg-Wes Mountain Catchment Area (figure 4.20). This protected area is covering the western peripheral land on the western part of the urban edge of Montagu. The Montagu Mountain Local Nature Reserve is bordering the town, and it is clear that some of the nature reserve is situated in the northern urban edge. It is important to protect this area and there should be no new cemeteries developed in this part of Montagu. There is also the Montagu Eeufees Nature Reserve that is situated in the southern part of the urban edge. This nature reserve can have an impact on the developing of new cemeteries, as previous mention this area is potentially suitable for new cemeteries. However, the eastern peripheral land has no protected or nature reserve areas, and new cemeteries can be developed here.

On a regional scale, the large protected areas are situated in the north eastern part of the Langeberg District, in the Langeberg mountain catchment, and as previously discuss above, it is only Ashton and Montagu which is affected by this protected area. However, as seen in 4.22, the Vrolijkheid Nature Reserve can influence the location of a regional cemetery in the McGregor and Bonnievale area.

4.3.4 SLOPES

The slope of a specific area plays a vital role in the development of new cemeteries and it is important for cemeteries to be situated on an area that is not below or greater then $2^{o} – 9^{o}$ slope angle, as this will have an effect on storm water drainage of the cemeteries (Judge 2012). This slopes in the towns of the Langeberg District as seen in figure 4.2 are indicated with two shades of colours to indicate the slopes lower than 2o and greater than 9o. These areas would not be suited for new cemeteries and it is important for the Municipality to consider this factor before determining new cemeteries in the future. The Langeberg District is situated between two large mountain ranges, namely the Langeberg Mountain Range and the Riviersonderend Mountain Range. These mountain ranges have an effect on how the towns in the Langeberg have developed and when especially focusing on the town of Montagu, it is clear that the Langeberg mountain range influenced the shape of this town (Figure

3.4(d)). The slopes of each town in the Langeberg District, as well as the slopes on a regional level are discussed below, in order to determine where the optimal location for new regional cemeteries ought to be.

McGregor is situated in a rather flat area, as one can see in figure 4.17. The large surrounding peripheral land of McGregor has a slope below 2o. Although a large flat area would seem to be prefect to develop new cemeteries, is it important to realize that a slope which is below 2^o is not suitable for cemeteries, as this will cause the water to accumulate, causing health problems in this area. However, as the results indicated for McGregor the best suitable open land to develop new cemeteries could potentially be in the southern peripheral land on the southern urban edge. There are open white patches scattered in this area, which show potential for new cemeteries.

In Bonnievale, the north western peripheral land north of the urban edge indicates that the slope is greater than 9^o, making this area not suitable for cemeteries. The peripheral land on the southern part of the urban edge indicates that the slope is below 2^o, which is too flat to create new cemeteries. However, in the northern peripheral area north of the urban edge are potential suitable land to develop new cemeteries, as there are large areas where the slope is between 2^o and 9^o, making it the perfect location to develop new cemeteries, as seen in figure 4.18. The area close to the western border of the urban edge are also potentially suitable to develop new cemeteries and because the New town cemetery is situated here, it could be argue that an extension of this cemetery is highly possible.

Ashton is situated in the middle of the Langeberg District and the northern peripheral land north of the urban edge has slopes of greater than 9^o, while the southern peripheral land south of the urban edge has a large flat area with a slope below 2^o , again making it not suitable to develop new cemeteries as seen in figure 4.19. It is illustrated that the peripheral land further south and southeast have a suitable slope gradient, which is potentially suitable for new cemeteries. Wes from Zolani is another large area suitable for new cemeteries.

Being situated close to the Langeberg Mountain range Montagu has far more unsuitable land, as the slopes for most of the northern and western peripheral land is greater than 9^o , making it unsuitable for new cemeteries in these areas (figure 4.20). On the southern urban edge of the town are large open areas where the possible location for a new cemetery is certain. However, the population of Montagu is very large and the need for new cemetery land, as calculated in this study, is far greater than the southern suitable land. It is thus important for the Municipal to focus on the scattered areas with the

correct slope, to develop new smaller cemeteries in order to reach the amount of burial land, which is required.

Robertson have large flat areas, which is below 2º, in the surrounding peripheral land west and east from the urban edge. South from the urban edge is an area with a slope greater than 9º, making it not suitable for new cemeteries. During the analysis of figure 4.21, it is also discovered that west from the existing White Street cemetery is a large suitable area with the appropriate slope to develop new cemeteries. However just like in the town of Montagu, Robertson needs even a larger amount of land to developing new cemeteries as calculated in the second part of the results. Other areas like the north eastern urban edge of the town is also suitable for the development of new cemeteries and can help with reaching the required amount of cemetery land.

On a regional scale the slopes of the LDM indicates that a large flat area, with a slope below 2º , is situated between the towns of Ashton and Robertson, with some scattered spots between these towns where the optimal location could be to determine new regional cemeteries. In the northern part of the Langeberg District the land is not suitable for new cemeteries, as the Langeberg mountain region is situated here. As illustrated in 4.22, Montagu is situated close to the Langberg mountain range, however there is a potential to develop a regional cemetery south from this town. There is also a large area between the town of Ashton and Bonnievale where the slopes is greater than 9º, indicating that this area would not be suitable for a regional cemetery. There is however, a potential to develop a regional cemetery between McGregor and Robertson, as scattered areas indicates the correct slope for developing a cemetery in this area. The calculation to determine how much land is needed to develop a regional cemetery was created by adding the population of all the towns in the Langbeerg District. As mentioned previously, the land needed for a regional cemetery is a very large amount and three possible regional cemeteries will be the best option for the Langeberg District.

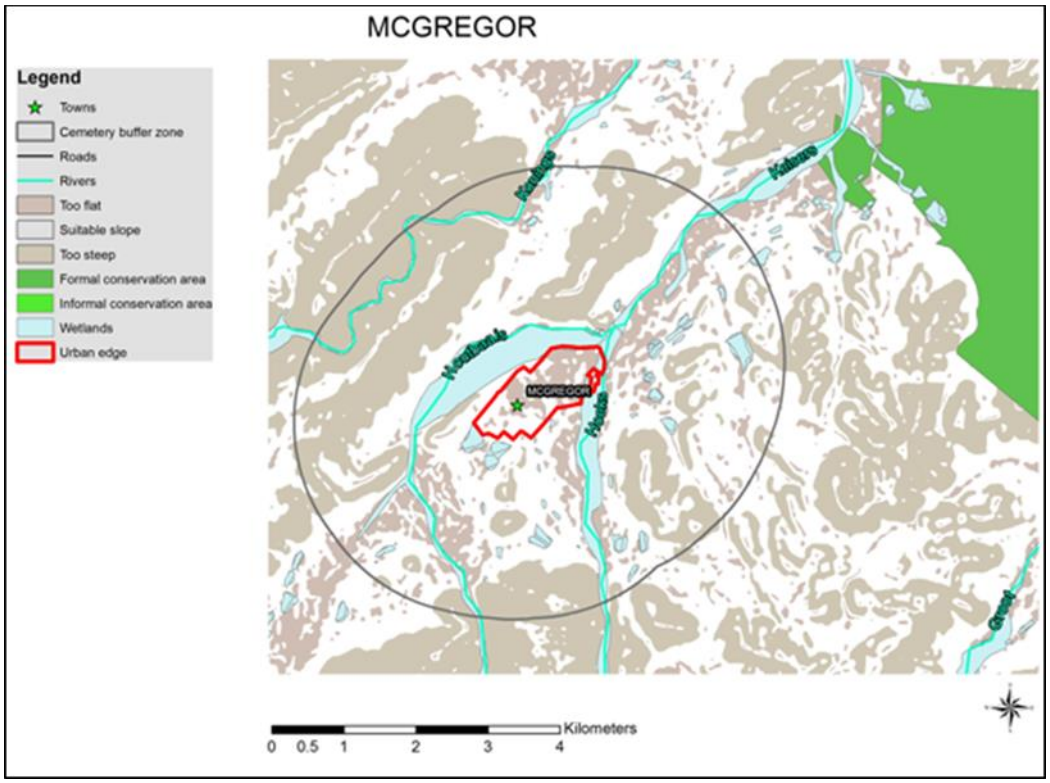

Figure 4.18: Factors influencing the location for new cemeteries in McGregor

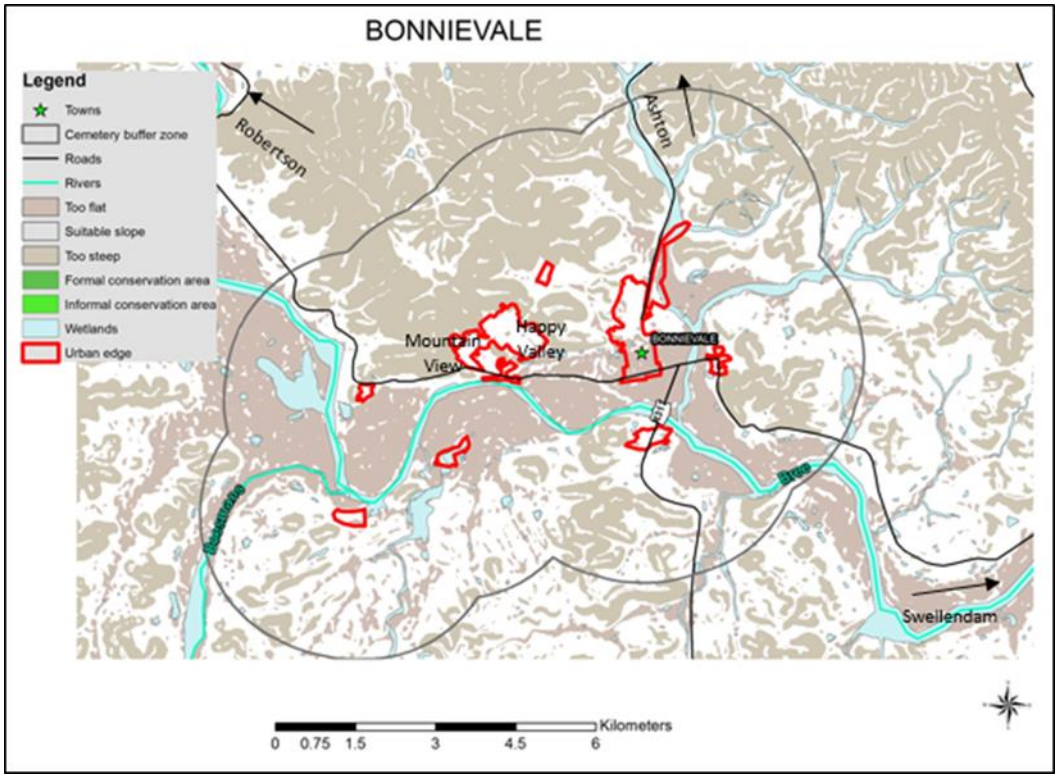

Figure 4.19: Factors influencing the location for new cemeteries in Bonnievale

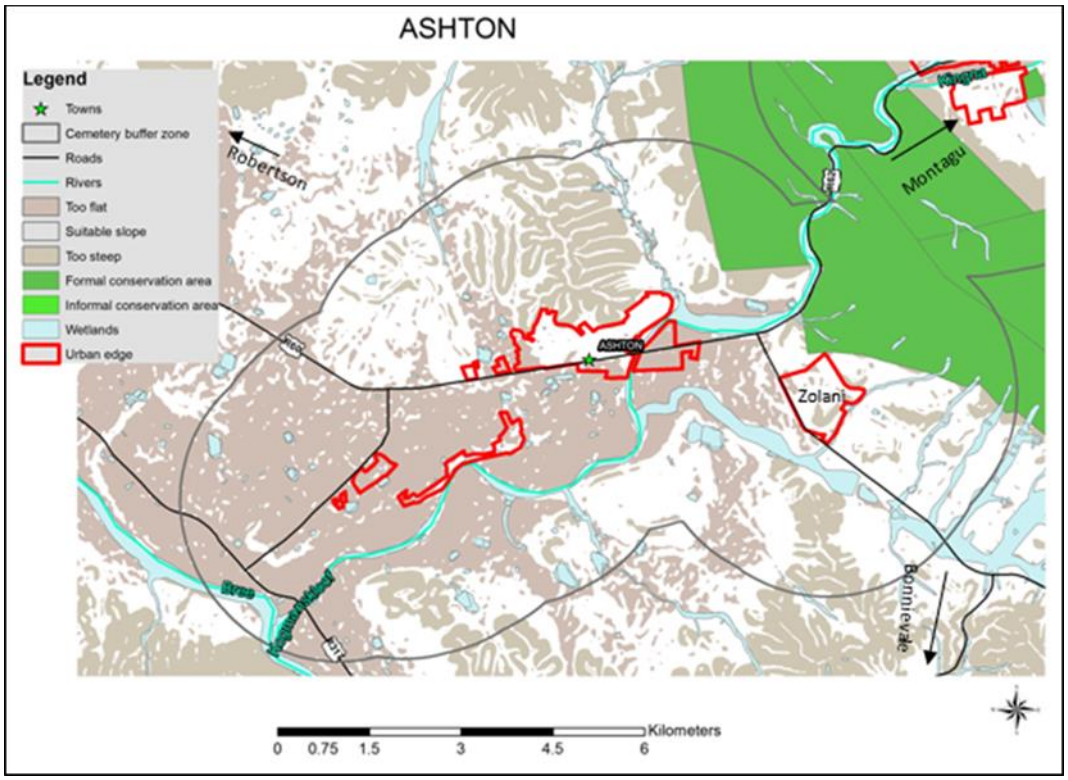

Figure 4.20: Factors influencing the location for new cemeteries in Ashton

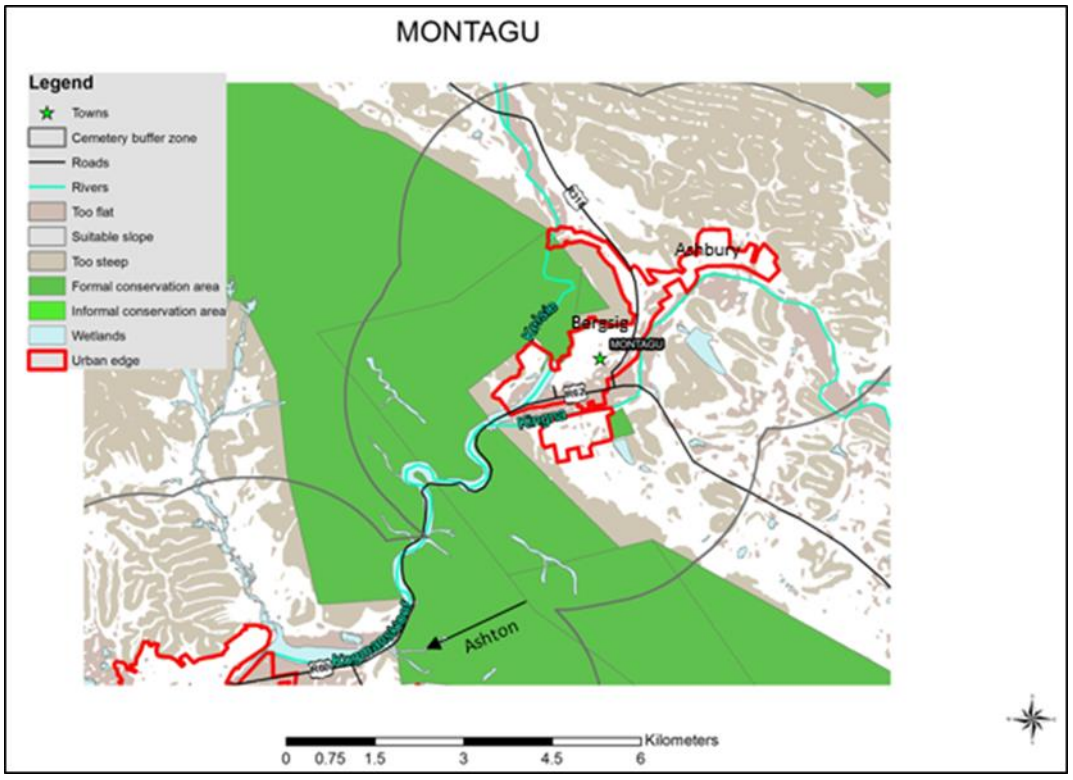

Figure 4.21: Factors influencing the location for new cemeteries in Montagu

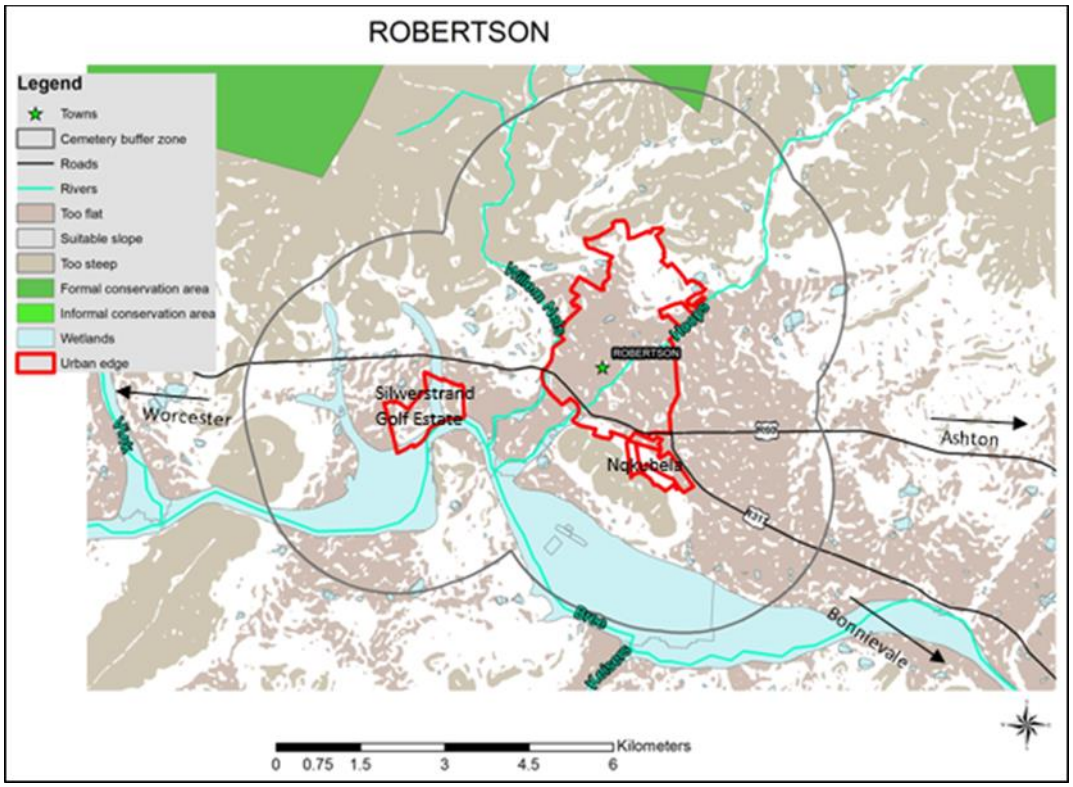

Figure 4.22: Factors influencing the location for new cemeteries in Robertson

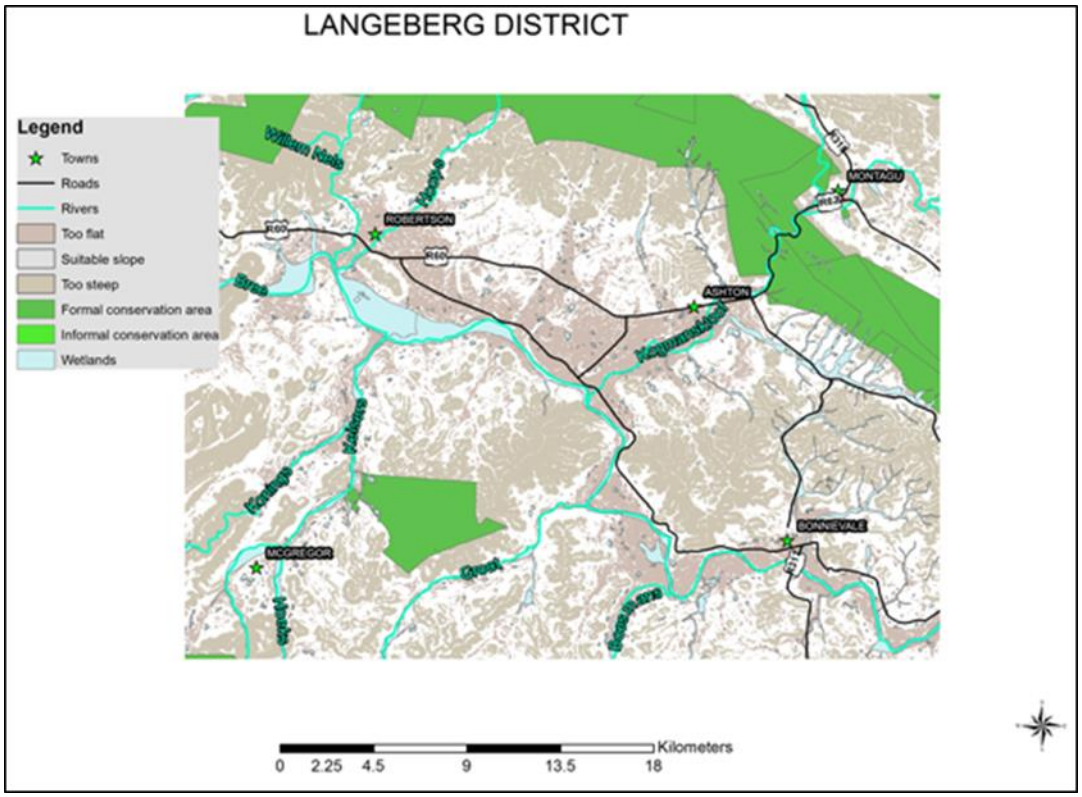

Figure 4.23: Factors influencing the location of new regional cemeteries in the Langberg District

As seen in this section above, the factors, which is identified and have an impact on the location for new cemeteries are land cover, rivers and wetlands, protected areas and slopes. Although these factors where discuss separately, is it important to weigh these factor against each other as one set of factor alone could not determine the optimal location for new cemeteries.

4.4 DETERMINING WHERE THE OPTIMAL LOCATION FOR NEW CEMETERIES WOULD BE IN THE LANGEBERG DISTRICT

This section provides the results for the optimal location of new cemeteries in the LDM. Chapter 2 of this study used the MCE device to compare specific variables, which ultimately led to the visualisation of the suitable areas to develop new cemeteries. The various maps in this section illustrate the location of the existing cemeteries, analysing if the existing cemeteries are suitably located, using the MCE device. The CSIR cemetery buffer, described in Chapter 2, are added to ensure that the new locations of the cemeteries in the towns of the Langeberg do not exceed the specified distance. The regional cemeteries do not include this cemetery buffer. The CSIR guidelines specify that the required cemetery buffer for large cemeteries are 30 kilometres from the urban edge of a town. No towns in the LDM are situated further than 30 kilometres from each other, therefore the cemeteries buffer on a regional scale, is irrelevant. The identified locations of the new cemeteries of each town and the regional cemeteries are discussed in-depth, explaining the location and physical surroundings of the new cemeteries. Several of the suitable cemetery locations are divided into small cemetery areas, providing the LDM to manage and develop the proposed new cemeteries during a certain period. This will ensure a good planning process for developing new cemeteries. The costs involved will be less, ensuring cost effectiveness as these areas are developed over time. The order in which results is discussed, corresponds with the area size calculated in the second section of the results. McGregor is firstly discussed, followed by Bonnievale, Ashton, Montagu, Robertson and the regional cemeteries of the Langeberg area.

4.4.1 OPTIMAL LOCATION FOR NEW CEMETERIES IN MCGREGOR

McGregor is situated between the two rivers Houtbaais river and Hoeks river. Figure 4.24 indicates that the existing Tindall cemetery is actually located in a not suitable area, according to the variables, which is focused on in this study. However, the proposed new cemetery to be develop in McGregor as indicated below is located on the southeastern part of the outer urban edge of the town. This

location does fall in the cemetery distance buffer zone and do meet all the criteria which is making this location a suitable location for a new cemetery for the town of McGregor.

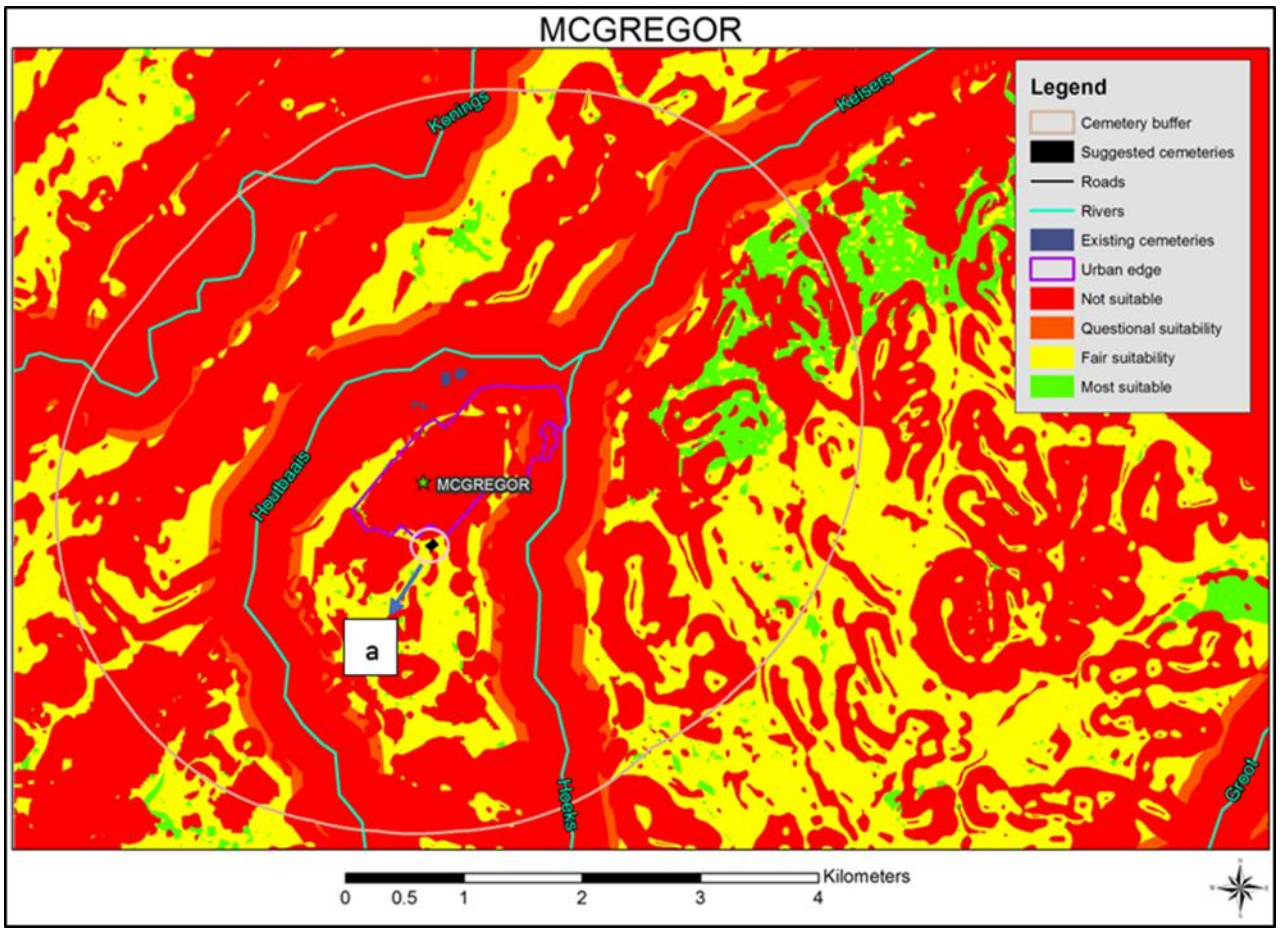

Figure 4.24: Proposed location for a new cemetery in McGregor

McGregor cemetery (a)

The proposed cemetery is situated near Smith street and is 5 200m^2 . This new cemetery is big enough for this town as it was calculated in the study that the area needed for new cemeteries in McGregor are 5 139m^2.

Figure 4.25: Proposed McGregor cemetery (a)

4.4.2 OPTIMAL LOCATION FOR NEW CEMETERIES IN BONNIEVALE

Bonnievale is the second smallest town in the Langeberg district. Figure 4.25 illustrates, according to the variable focussed in this study, the four existing cemeteries are situated in suitable and fair locations. According to the cemetery land needed, as calculated in the study, it is proposed that three new cemeteries should be developed in Bonnievale, not exceeding 71 657M2. These proposed areas, meeting all criteria in making the location suitable or fairly suitable, is illustrated in Figure 4.26, falling in the cemetery distance buffer zone.

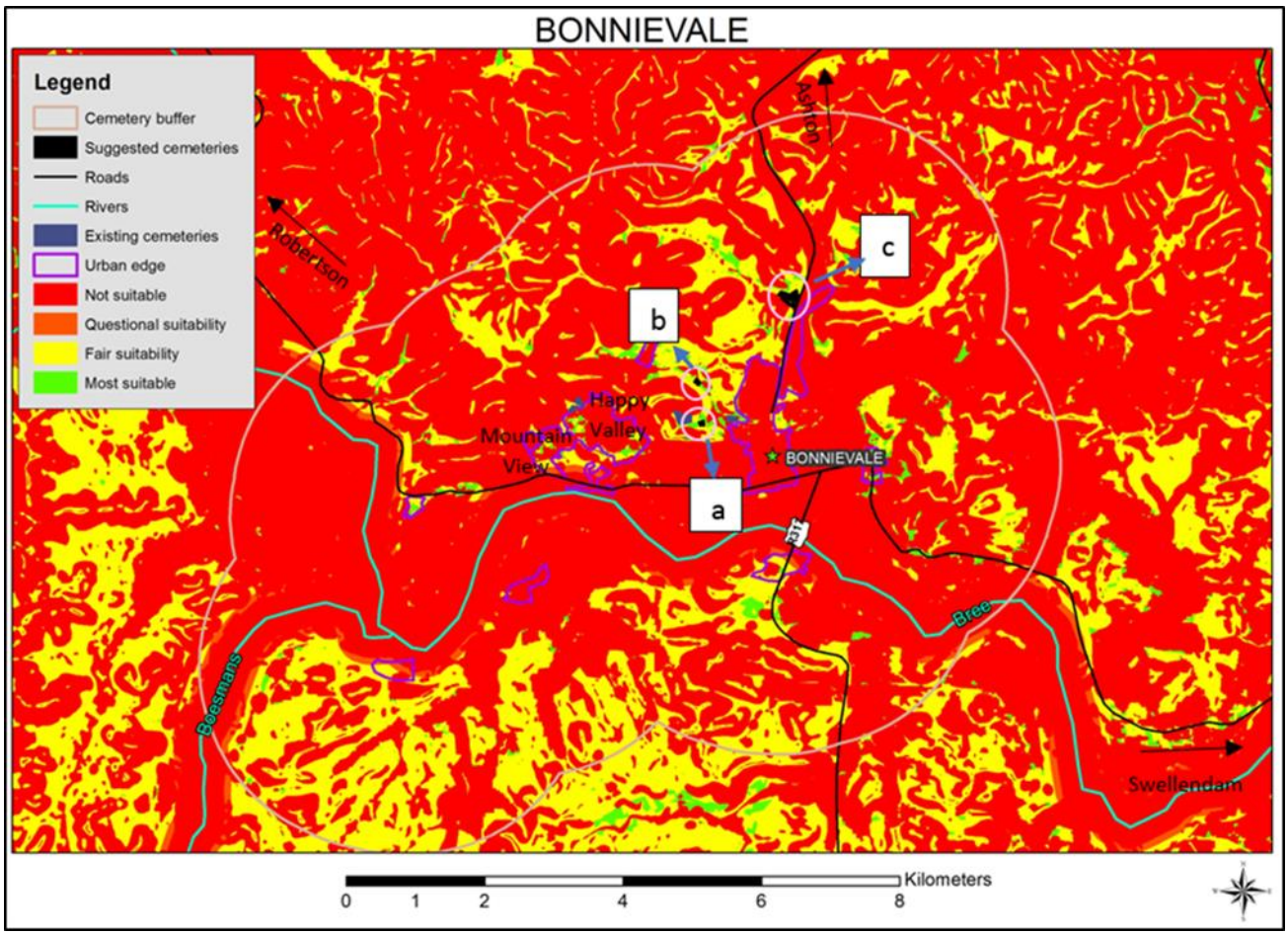

Figure 4.26: Proposed location for new cemeteries in Bonnievale

Bonnievale cemetery (a)

The proposed cemetery location is situated near the existing New Forest cemetery. It is proposed that this cemetery consist of two areas which makes the planning proses for the LDM easier (figure 4.26). It is proposed that this cemetery comprises two areas, simplifying the planning process for the LDM (Figure 4.26). It is proposed that Area 1, indicating 8 000 m^2, should be developed first. When this area reached its full capacity, Area 2, also indicating 8 000 m^2, should be developed. The total area for the proposed Bonnievale cemetery (a) indicates 16 000 m^2.

Figure 4.27: Proposed Bonnievale cemetery (a)

Bonnievale cemetery (b)

This cemetery is situated 600m north of the abattoir and would be located on a gravel road, entering Forest Street (Figure 4.27). This cemetery comprises one area, encompassing 8 000 m^2.

Figure 4.28: Proposed Bonnievale cemetery (b)

Bonnievale cemetery (c)

This cemetery is situated on the northern peripheral land of the urban edge and is situated 480m north from the Mooivallei cheese factory. Figure 4.28 illustrates, that this cemetery comprises six areas, embracing 8 000 m^2. These areas are numbered in the order it is planned to be developed, once the previous area reached its full capacity. The cemetery is situated in the cemetery distance buffer zone and the total of this cemetery area will be 48 000 m^2.

Figure 4.29: Proposed Bonnievale cemetery (c)

4.4.3 OPTIMAL LOCATION FOR NEW CEMETERIES IN ASHTON

Ashton is the most central town of the LDM. This town is situated on the R60, between Robertson and Montagu. The four existing cemeteries in Ashton are all situated on fairly suitable locations, according to Figure 4.29. The total size of land needed to develop new cemeteries, calculated in this study, indicates 74 042M2. It is proposed that four new cemeteries should be developed in Ashton. These proposed areas either indicate extensions of existing cemeteries, or new cemeteries. These propose areas would be allocated in the cemetery distance buffer zones, meeting all the criteria for developing new cemeteries.

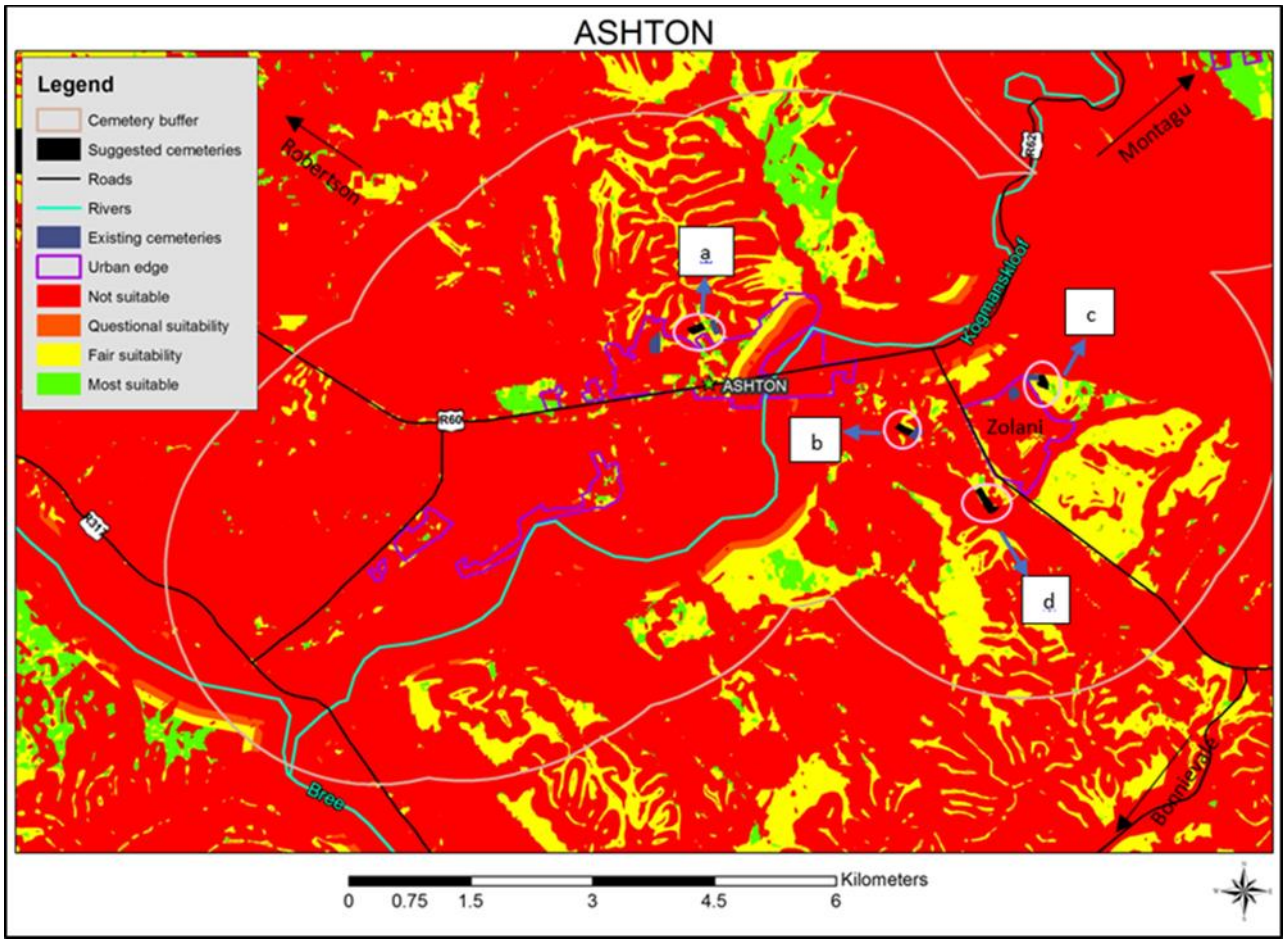

Figure 4.30: Proposed location for new cemeteries in Ashton

Ashton cemetery (a)

As mentioned in the study, the Cogmanskloof cemetery has reached its full capacity usage. It is propose that this cemetery could be extended, as the location of these extended parts is fairly suitable areas. The cemetery will comprise two proposed areas where both are 8 000 m^2 and the number in the figure indicates the order in which these cemeteries areas should be developed (Figure 4.30). The total area of the proposed Ashton cemetery (a) will take up 16 000 m^2.

Figure 4.31: Proposed Ashton cemetery (a)

Ashton cemetery (b)

This proposed cemetery also indicates an extension of the existing Silo cemetery. Although the Silo cemetery used 55% of its capacity, it is indicated in Figure 4.31 that fair suitable land is available next to this cemetery. This cemetery comprises two proposed areas where both are 7 000 m^2. Again, these areas should be developed according to the numbers indicated in Figure 4.32. When the initial area reached its full capacity, area two can be developed. The total area of the proposed cemetery area is 14 000 m^2.

Figure 4.32: Proposed Ashton cemetery (b)

Ashton cemetery (c)

This proposed cemetery will be located on the northern urban edge of Zolani. The existing New Zolani cemetery is situated here. Suitable land is available next to this existing cemetery. This proposed cemetery comprises two areas (Figure 4.32). Area 1 is 7 000 m^2 and should be developed first. Only after this area reached its full capacity usage, the second area should be developed, indicating 8 000 m^2. The total areas of this proposed is 15 000 m^2.

Figure 4.33: Proposed Ashton cemetery (c)

Ashton cemetery (d)

This proposed cemetery establishment would be 300m from the R60 road. This cemetery is situated on the farmland portion Gorree and as seen in Figure 4.33 this cemetery will comprise four areas. These areas should be developed according to the number indication in Figure 4.33. As the first area reached its capacity, the next area should be developed. Area 1 and 3 will both acquire 7 000 m^2 and Area 2 and 4 will both acquire 8 000 m^2. The total area of the proposed cemetery indicates 30 000 m^2.

Figure 4.34: Proposed Ashton cemetery (d)

4.4.4 OPTIMAL LOCATION FOR NEW CEMETERIES IN MONTAGU

Montagu is situated on Route 62, close to the Langeberg mountain range. Several protected areas are included in the surrounding areas. According to the variables in this study, Figure 4.34 illustrates that two of the three existing cemeteries are situated in an unsuitable area. These cemeteries are both situated on the southern urban edge of Ashbury. According to the criteria used to determine the optimal location of new cemeteries, these cemeteries are situated too close to the Groot river. As calculated in this study, the total area needed to develop new cemeteries in Montagu are 87 609 m^2. It is proposed that three new cemeteries should be developed in Montagu. These proposed cemeteries are illustrated in Figure 4.35. All the proposed new cemeteries would be situated within the cemetery distance buffer. These proposed new cemeteries meet the criteria for developing cemeteries, situated in suitable locations.

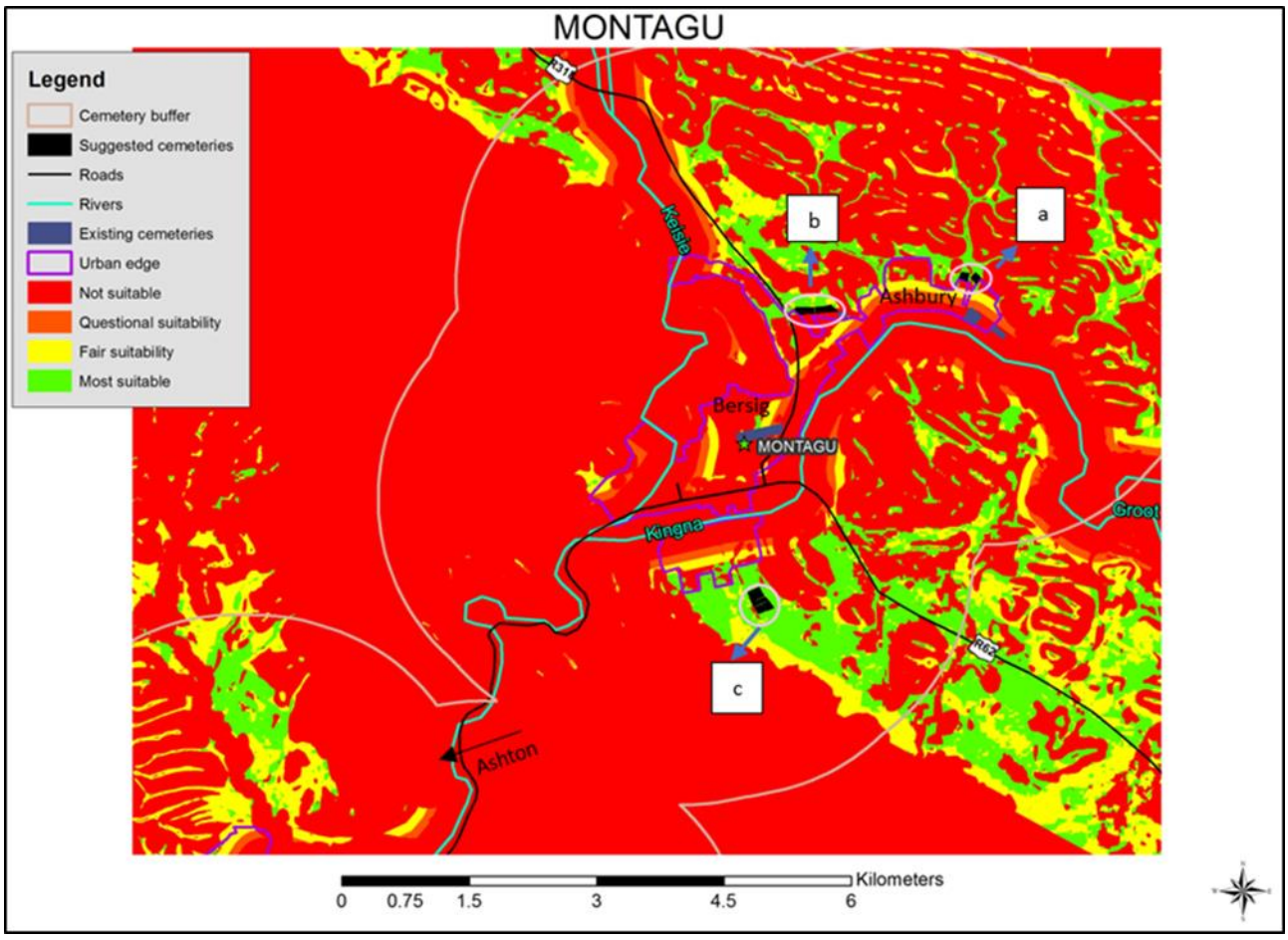

Figure 4.35: Proposed location for new cemeteries in Montagu

Montagu cemetery (a)

This proposed cemetery would be situated on the northern urban edge of Ashbury. As seen in Figure 4.35, this cemetery comprises two areas, both indicate 8 000 m^2. It is that Area 1, situated near Swartolien Avenue, be developed first and only after it reached it full capacity, Area 2 could be used which would be situated close to Besembos Avenue. The total area of the proposed cemetery indicates 16 000 m^2.

Figure 4.36: Proposed Montagu cemetery (a)

Montagu cemetery (b)

This proposed cemetery would be situated near the Montagu golf course. As seen in Figure 4.36, this proposed cemetery will include four areas. Area 1, 2 and 3, indicate a size of 8 000m^2. The remaining Area 4 is 7 800 m^2. It is important to use these areas according to the indicated number of the area. As the first area reached its full capacity, the next area need to be developed. The total area of the proposed cemetery is 31 800 m^2.

Figure 4.37: Proposed Montagu cemetery (b)

Montagu cemetery (c)

This proposed cemetery would be situated in the peripheral land on the southern urban edge of Montagu, near Koeniebos Street. Figure 4.38 illustrates that proposed cemetery comprises five areas. These five areas are all 8 000 m^2 and should be developed according to the numbers illustrated in Figure 3.37. Once the first area reached its full capacity, the next area can be used. The total area of the proposed cemetery is 40 000 m^2.

Figure 4.38: Proposed Montagu cemetery (c)

4.4.5 OPTIMAL LOCATION FOR NEW CEMETERIES IN ROBERTSON

Robertson is the largest town, situated in the LDM. This town comprises only three existing cemeteries, in which White Street cemetery is located in an unsuitable cemetery location. This cemetery is located too close to the Willem Nels river, according to the criteria used in this study. It was calculated that the total new cemetery land, needed for cemeteries in Robertson are 391 289 m^2. Compared to the other towns in the LDM, Robertson holds a far larger need for new cemeteries. After analysing the results collected from the variables used in the MCE, this study proposes seven new

cemeteries be established in the peripheral land near Robertson. As seen in Figure 3.39, all these new cemeteries would be established in a suitable location. These new cemeteries would also be situated inside the cemetery distance buffer zone.

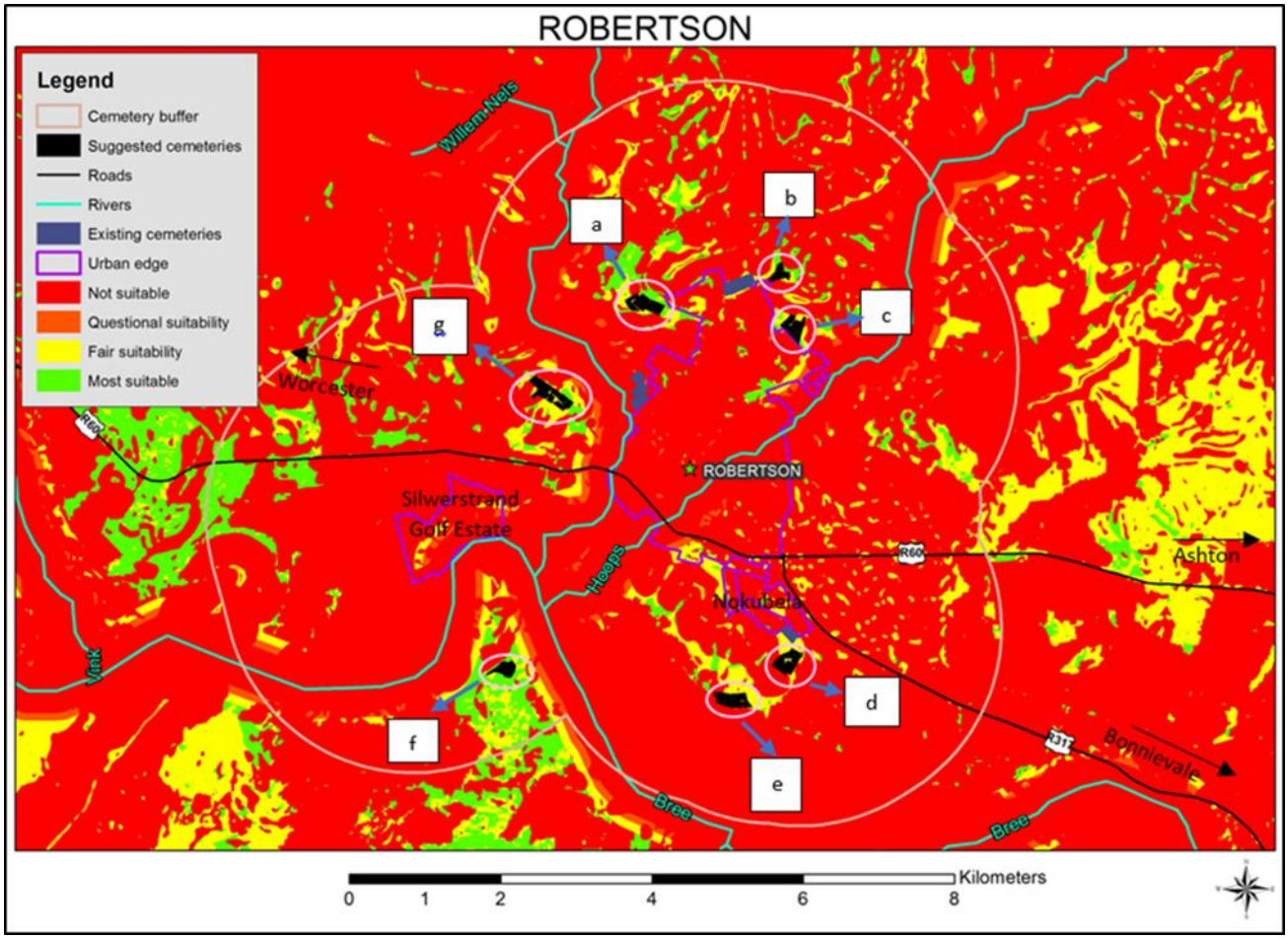

Figure 4.39: Proposed location for new cemeteries in Robertson

Robertson cemetery (a)

The proposed cemetery would be situated on the peripheral land close to the northern urban edge of Robertson, near Paddy Street. This cemetery will comprise eight areas, in which all indicate 8 000 m^2. As illustrated in Figure 4.40 these areas should be developed according to the number indicated. When the first area reached its full capacity, the following area should be developed. The proposed cemetery indicates a large cemetery, with 64 000 m^2.

Figure 4.40: Proposed Robertson cemetery (a)

Robertson cemetery (b)

This proposed cemetery area is situated near Muller Street, on the northern urban edge of Robertson. This cemetery will comprise four areas as seen in Figure 4.41. These areas indicate the same size of 8 000 m^2 and should be developed over time according to the numbers. The total area of the proposed cemetery indicates 32 000 m^2.

Figure 4.41: Proposed Robertson cemetery (b)

Robertson cemetery (c)

This cemetery will be situated on the eastern urban edge of Robertson, near Rose Street. Figure 4.42 illustrates, this cemetery will comprise six areas, of which all would be 8 000 m^2. This cemetery should be developed according to the numbers and each time the area is full, it should relocate to the next area as indicated in Figure 4.42 below. The total size of this cemetery will comprise 48 000 m^2.

Figure 4.42: Proposed Robertson cemetery (c)

Robertson cemetery (d)

This cemetery is proposed to be situated south of the urban edge of Nqkubela. Although the current cemetery of Nqkubela has used 50% of its capacity, the proposed new cemetery will be much bigger, providing burial space for the deceased of Nqkubela. This cemetery will comprise eight areas as indicated in Figure 4.43. These areas are 8 000 m^2 in size and should be developed according to the numbers indicated in Figure 4.43. As the previous area reaches its capacity the next area must be develop. The total area of the proposed cemetery indicates 64 000 m^2.

Figure 4.43: Proposed Robertson cemetery (d)

Robertson cemetery (e)

This proposed cemetery will be situated in the southern peripheral land of the southern urban edge of Nqkubela. and is situated 1,2 kilometres from the residential area of Nqkubela. As seen in Figure 4.44 this cemetery will also comprise eight areas, of which each is 8 000 m^2. As seen in the picture the first area that ought to be developed is indicated with "1". As the areas reach their capacity, the following area according to the chronological number system, should be developed. The total area of the proposed cemetery is 64 000 m^2 in size.

Figure 4.44: Proposed Robertson cemetery (e)

Robertson cemetery (f)

This proposed cemetery will be situated 1,7 kilometres south from Silwerstrand Golf Estate on the south-western side of the urban edge of Robertson. It will be located on the farm portion Appel Drift. As seen in Figure 4.45, this cemetery will comprise five areas, of which each will be is 8 000 m^2. The first should be developed close to the road as seen in Figure 4.45 and as it reaches its full capacity, the following areas should be used according to the numbers. The total of the propose cemetery indicates 40 000 m^2.

Figure 4.45: Proposed Robertson cemetery (f)

Robertson cemetery (g)

This proposed cemetery will be located on the western peripheral land of the urban edge of Robertson. It will be situated 1,4 kilometres from the existing White Street cemetery. This cemetery will be the largest proposed local cemetery for a town in the LDM. As seen in Figure 4.46, this cemetery will comprise ten areas, of which each is allocated 8 000 m^2. This proposed cemetery will be 80 000M2, indicating as the largest local cemetery in the LDM.

Figure 4.46: Proposed Robertson cemetery (g)

4.4.6 OPTIMAL LOCATION FOR NEW REGIONAL CEMETERIES IN THE LANGEBERG DISTRICT

As the above results focusses on the optimal location of new cemeteries on a local scale, this section focusses on developing new cemeteries on a regional scale. As seen in Figure 4.47, no cemetery distance buffer zones are indicated. As explained in Chapter 2, the buffer zone for large cemeteries are 30 kilometres. This do not restrict the development for new cemeteries according to the appropriate distances, as all the Langeberg towns are situated closer than 30 kilometres from each other. This is the reason for not adding the cemetery distance buffer zone on the regional scale for determining new regional cemeteries. The calculation for determining the land needed for new regional cemetery was derived from the population of all five towns in the Langeberg. The population of these towns were combined on completion of the calculation, determining the land needed to develop new cemeteries. The result of the calculation indicates that 2 394 054 m^2 of land is needed to develop the new regional cemeteries. As illustrated in Figure 4.46, this study proposed three regional cemeteries for the LDM. These three regional cemeteries, according to the findings of the criteria used, will be situated in suitable locations.

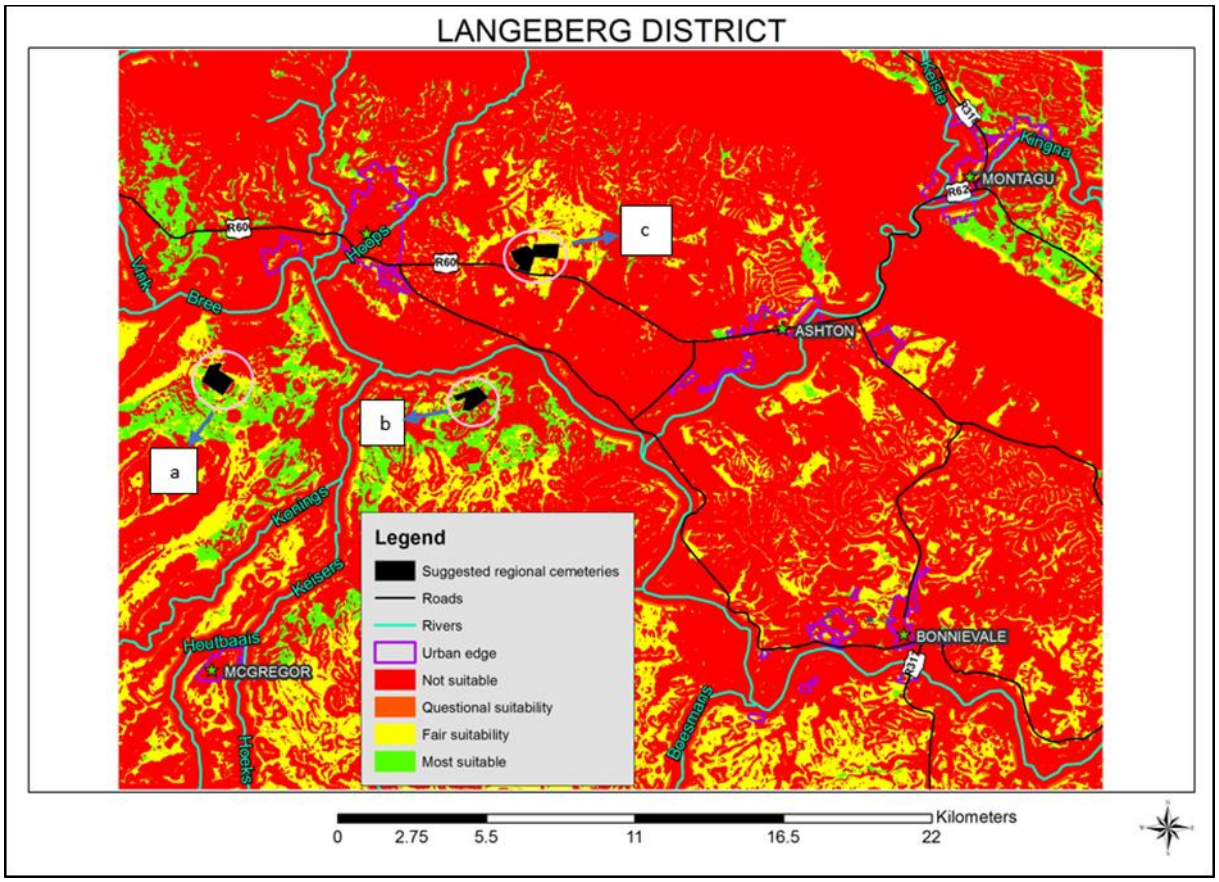

Figure 4.47: Proposed location for new regional cemeteries in the Langeberg District

LDM Regional cemetery (a)

The propose regional cemetery will be situated five kilometres from Silwerstrand Golf Estate. This area is situated on the farm portion Zanderberg Fontein. This regional cemetery will comprise only one large area as seen in Figure 4.48, with a size of 800 000 m^2. The Langeberg Municipality could decide on the layout of this proposed regional cemetery.

Figure 4.48: Proposed LDM Regional cemetery (a)

LDM Regional cemetery (b)

The propose regional cemetery will be situated in the centre of the Langeberg district and the closest residential area to this proposed area, is Nqkubela, situated 4,7 kilometres north of this proposed regional cemetery. This regional cemetery is situated on the farm portion Uitnood. This cemetery will comprise one large area as indicated in Figure 4.49, indicating 600 000 m^2.

Figure 4.49: Proposed LDM Regional cemetery (b)

LDM Regional cemetery (c)

This proposed area is situated on the R60 between the towns of Robertson and Ashton. Indicating the biggest regional cemetery in the Langeberg district. As seen in Figure 4.50, this cemetery will comprise one large area, indicating 1 000 000 m^2. Because of the large area of this cemetery, the Langeberg Municipal can develop a layout which suites the proposed regional cemetery.

Figure 4.50: Langeberg Regional cemetery in the Langeberg District

The results in this study, clarified the current cemetery situations of the LDM, calculating the area needed to develop new cemeteries, identifying the location of the factors which impact the location of new cemeteries. The MCE device was used to identify the optimal location by comparing these factors, for new cemeteries in the local town of the LDM, and determining the regional cemeteries for the LDM.

The next section focusses on the management and planning strategies, which the LDM need, ensuring that the existing cemeteries and the regional cemeteries are protected and governed in a sustainable manner.

4.5 MANEGEMENT AND PLANNING STRATEGIES FOR THE EXISTING AND NEW CEMETERIES IN THE LANGEBER DISTRICT

After analysing the current cemetery situation and determining the optimal location of new cemeteries, it was found that the Langeberg district comprises 17 existing cemeteries (in which some reached its full capacity), 18 proposed new local cemeteries (in which some of these new proposed cemeteries are extensions of existing cemeteries) and three regional cemeteries. It is thus the LDM's responsibility to control these cemeteries in a sustainable way, preserving and enhancing the cultural and natural values of the specific area in which these cemeteries are situated. This section clarifies certain management and planning strategies for existing and new cemeteries in the Langeberg district, which ultimately lead to achieving the last objective of this study as mentioned in Chapter 1. This section provides managing and planning strategies for the following challenges, which the Langeberg

district is facing. The first aspect that this study focussed on, was the maintenance of cemeteries, ensuring that the existing and new cemeteries do not lose its cultural and heritage value. The second aspect focusses on strategies to create a multipurpose land-use, provide various recreational facilities, ensuring that the cemeteries are a visit-friendly location. The last factor focusses on the safety of the individuals visiting the cemetery sites and the protection of the cemetery (eliminating vandalism).

4.5.1 MAINTENANCE STRATEGIES FOR CEMETERIES

As indicated by the results from this study, certain cemeteries reached its full capacity. New burials cannot occur in these areas. It is the LDM's responsibility to maintain these cemeteries, ensuring they do not lose their cultural and heritage value. The LDM should provide the following maintenance:

- General Maintenance: Specific staff members need to be appoint in managing the conventual responsibilities of managing a cemetery.
- Removal of refuse: The LDM must appoint as indicated by the results from this study, certain cemeteries reached its full capacity. New burials cannot occur in these areas. It is the Langeberg Municipality's responsibility to maintain these cemeteries, ensuring they do not lose their cultural and heritage value. The Langeberg Municipality should provide the following maintenance:
- Landscape maintenance: It is stipulated in the Langberg Municipal By-law that:

"19 (5) The municipality shall have the right to remove, trim of prune any plant which extends beyond the boundaries of the grave plot upon which it is planted or which is untidy."

Ensure that the landscape of the cemetery is maintained. This maintenance should be completed in a manner, ensuring that the graves are not damaged. The LDM should budget and contract private companies specialising in this service, ensuring that the cemeteries are at least cleaned once a month.

4.6.2 MULTI-PURPOSE LAND USE FOR CEMETERIES

The literature indicates that a cemetery that was once a major spiritual landscape and integral part of the local community, declined to a place forgotten and to be avoided (Beebe 2003; Crankshaw et al. 2016). The LDM experiences the same phenomena. The main reason for this indication, is that the modern culture views death and dying as a place that was once seen; a place of hope and sacredness, is now viewed as a place of dread. This section provides strategies and recommendations on how the perception of cemeteries can be changed by developing a multipurpose landscape, providing a place for recreation and leisure.

Instead of using cemeteries as a single land-use type, several examples in the literature indicate that cemeteries can be combined with other land-use types, such as open parks, various functions or wedding venues (McMillan 2016). The LDM comprises the traditional use of cemeteries, covered with tombstones, taking up space. This study recommends that the LDM should focus on alternative ways in burying the dead.

Green burials indicate an emerging way in which the deceased are being buried (Carlton & Coutts 2010). Green burials provide an eco-friendly approach to bury the deceased loved ones. Large open grass areas can be developed which: create public parks for individuals to go for leisure purposes, also playgrounds can be developed for the kids at these new proposed cemeteries. The regional cemeteries identified in the LDM can be the perfect location to develop multipurpose cemeteries, where there is space for combining other land-uses. The LDM can even develop venues on these graveyards where functions and birthday celebrations can be held (McMillan 2016). This would assist, changing the perspective of the citizens of the Langeberg district, changing the stereotyping views of cemeteries as just a place of sorrow, death and vandalism.

4.6.3 PROTECTING AND CREATING A SAFE CEMETERY ENVIRONMENT

Several news articles and news bulletins in recent years, reported that cemeteries became dangerous areas to visit. Cemeteries are being vandalise and damaged. This phenomenon is not only evident in South Africa, but globally (Erkal & Ozhan 2014; Stangl 2007). Vandalism contributes to the decline of visits to cemeteries, as individuals are afraid of crime. This section focusses on the importance of safety in the cemeteries and recommend safety processes that the LDM could follow, in assisting the cemeteries as a safe place for families visiting their loved ones' graves.

The Langeberg Municipal By-Law, which focus on the control of cemeteries, stipulated that:

"8 (7): No person shall destroy or do or cause to be done any damage to, or shall mark or draw or erect any advertisement, bill or placard upon, or in any other way deface any grave, tombstone, monument, wall, building, fence, railing or other structure or any road in any cemetery"

This By-Law was created to prevent vandalism at the existing cemeteries of the Langeberg. Although the specific By-Law cannot prevent individuals from vandalising tombstones, the community of the Langeberg district should join forces with the authorities in exposing those guilty of vandalism. The LDM should provide safety measures, ensuring that these cemeteries will not be vandalised. The South African literature state that cemeteries in Johannesburg encounter daily vandalism and the security companies in Johannesburg situated perimeter sensors in the cemeteries (Smith 2013). This sensor detects when a tombstone is moved, sending an alarm message to the nearest police station, in which the police could be notified in time to prevent large damages to cemeteries (Smith 2013). The LDM can install these sensor devices in the new cemeteries, providing security guards at the cemeteries to prevent vandalism and ensuring cemeteries as a save place.

LDM are advised to implement the management and planning strategies discussed in the study. The Municipality should provide a budgeting plan, ensuring that these services are incorporated, to ensure providing these management services. Cemeteries indicate a type of land-use difficult to continuously maintain, as these areas is not a source of income for the LDM, to provide management services. The LDM should provide mix use areas, in which other services and facilities could be incorporated with the cemetery areas to generate an income. This will assist in providing these management services mentioned.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

This study comprised two overarching aims, which was: 1) to determine the optimal size and locations for developing new regional cemeteries in LDM; and 2) to provide sustainable planning and management strategies for the existing and new cemeteries in the LDM.

The first objective of this study was to review all the appropriate literature on managing and developing new cemeteries. It was noted in the literature review that the rapid increase in population in several cities caused a lack of availability for burial space in existing cemeteries. Cemeteries are also becoming less of a dominant priority, as demands for other infrastructure (housing, commercial) are prioritised. As indicated in this study, the existing cemeteries in the LDM is also rapidly reaching its full capacity. It was important to collect appropriate literature on planning new cemeteries combined with factors to be considered when determining the location for new cemeteries.

The second objective of this study was to produce a clear illustration of the current cemetery situation of the LDM. This study established that four from the existing 17 local cemeteries situated in the five main towns of the LDM, already reached its full usage capacity. Six from the 13 available cemeteries are over 90% of usage capacity. These findings illustrated that the LDM indicates a need for developing new cemeteries, as over the next few years more existing cemeteries would reach its full usage capacity.

The third objective of this study was to calculate the size of land needed to develop new cemeteries for each of the local towns in the LDM, determining the area needed to develop regional cemeteries for the LDM. It was possible to reach this objective, as this study used the CSIR cemetery formula to determine the required area needed for new local or regional cemeteries. This formula was used to determine new cemeteries for the next 30 years. The CSIR guidelines providing the cemetery formula, also provided the cemetery size criteria, assisting in determining the quantity cemeteries each town ought to have, according to the size criteria. The number of regional cemeteries was also estimated in this study.

The forth objective of this study, was to analyse and determine the factors which could affect the optimal location of new cemeteries in the LDM. Five factors focussed on, indicated; land cover,

location of rivers and location of wetlands, protected areas and slopes. This objective was reached through creating maps, illustrating where in the LDM these components are situated and what effect these factors have on locating new regional cemeteries.

The fifth objective of this study was to determine the optimal locations for developing new regional cemeteries in the LDM, by comparing all the identified factors in this study, using the MCE device. This MCE device managed to illustrate using maps, created on ArcMap, the suitable suggested locations for developing new cemeteries. This device used a unique criteria system which was developed in this study by conducting appropriate literature on the factors effecting the optimal location of new cemeteries. This objective was met in this study, as the results indicated that 18 new proposed local cemeteries and three regional cemeteries were identified for the LDM.

The final objective of this study was to provide sustainable planning and management strategies for the LDM, aimed at the existing and new cemeteries. This study focussed on maintenance strategies, strategies in developing multipurpose land-use for cemeteries and strategies for protecting and creating a safe cemetery environment. Clear planning and management strategies are mentioned in this study and the final objective was met as indicated.

Based on the above summary the study achieved its aims and objectives.

5.2 IMPLICATION AND RECOMMENDATIONS

After developing the MCE device, assisting the process determining the optimal location of new regional cemeteries in the LDM, it is recommended that these propose cemeteries mentioned in the study could be implemented in the next review of the Integrated Development Plan (IDP) and Spatial Development Framework SDF of the municipality. This study could be used as an assisting guideline when developing and determining the location of new cemeteries. Should the municipality decide on developing these suggested cemeteries, this research document must be kept on record, ensuring that the location of these new cemeteries, is in the identified suitable cemetery areas. It is also recommended that the MCE device process used in this study, could also be implemented in other municipal development projects and can be used as device to assist in the planning process for additional land-use types. The MCE device compare influencing factors to determine optimal locations.

The LDM is a fairly small municipal and as any small municipal it is limited because of a lack of good infrastructure. It is important for this municipal to invest in proper GIS software, ensuring the appropriate staff members receive full GIS training courses, improving their developing skills of planning process whilst using this MCE device in GIS.

5.3 LIMITATIONS OF THE STUDY

This study was conducted by the gathering of data that was presented by the LDM. One limitation of this study were that the necessary procedures has to be taken every time new data is gathered from the municipality. This lead to a restriction of some data in which the municipality was not comfortable in sharing, which could have contributed more to the findings in this study.

5.4 FUTURE RESEARCH

This study focussed on developing new regional cemeteries in the LDM by calculating the acquired land needed to develop new cemeteries for the specific towns in the Langeberg district. The MCE device compared the influencing factors to determine the optimal location of these cemeteries. Further studies should be completed on developing a cemetery planning guideline for the LDM, as this municipality only comprises the municipal By-Law and lack cemetery implementation documents. A study is also suggested on providing ideas on mix land-use cemetery layouts, possibly contributing on changing the perception of cemeteries amongst individuals.

The results of this study can contribute in solving the cemetery challenge in the LDM. It is therefore recommended that the LDM establishes the proposed cemeteries identified in this study in the suitable location of new cemeteries.

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